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The government ownership of certain Atlantic coast canals is advocated in a joint resolution presented to the United States Senate by Senator Quay. He would authorize the Secretary of War to appoint a commission of engineers to ascertain at what cost the government could obtain absolute control over the property, rights and franchises of the Delaware & Raritan, the Chesapeake & Delaware and the Albemarle & Chesapeake canals, and all other canals connecting the great bays and waterways of the Atlantic coast states. The arguments advanced for this action are that the control of these canals by private corporations results in an unnecessarily heavy tax upon persons using them for transportation purposes, and that the government should control such important waterways. The same arguments would apply equally well to the government ownership of railways, telegraph lines, mines and, in fact, the bulk of large industrial enterprises.

An indictment for manslaughter in the second degree was recently found against the Manager of the Duluth Gas & Water Co. on the charge of having furnished polluted water, which caused a death from typhoid fever in Duluth, Minn. A large number of deaths from typhoid were reported in Duluth in December, and these are attributed, whether rightly or not, to the water supply. It is claimed that the intake well was leaky, admitting polluted surface water, and that the intake pipe did not extend far enough out from the shore. The city is distributing drinking water by means of sprinkling carts, and the company is extending the intake. The city proposes to build a water-works plant, bonds for that purpose having been voted recently. The Grand Jury that indicted the Manager, as above, also indicted the chief pumping engineer for perjury, in connection with an investigation of the company's works.

An example of rapid erection of structural iron and steelwork for skeleton fireproof buildings is the Siegel-Cooper Building, at 18th and 19th Sts. and Sixth Ave., New York city, the setting of the framework of which was completed Jan. 29. The foundations for the building were delivered complete to Milliken Bros., New York, contractors for the ironwork, on Nov. 1. During November the owners offered the contractors a bonus in consideration of their anticipating the contract time requirements for the erection of the framework, including the roof tier complete. Notwithstanding the strike on the building, from Nov. 18 to Dec. 18, the contractors were enabled to complete the setting of the last beam, column, bolts and tie-rods on the roof tier on Jan. 28, the time in which they were to complete this work in order to win the bonus being Feb. 1. Excepting a portion of the columns and beams in the first tier, which were put up by hand owing to the previous incompleteness of the foundations, the work has been entirely erected by machinery, the actual working time being exactly nine weeks since the foundations were finally completed, deducting the strike period. In this time seven complete tiers of work, amounting to between 7,000 and 8,000 tons of material, have been erected.

The American Line Steamship "St. Paul" was released from the sands of the New Jersey coast on Feb. 4, under the combined efforts of a northeast wind, her own screws and the tugs of the Merritt Wrecking Co. and the Chapman Wrecking Co., of New York. As far as can be now learned, the ship is in no way injured by her enforced stay of ten days upon the beach. In this connection it should be said that, for the first time on record, a steamship was in telephonic connection with land offices. As soon as the "St. Paul" grounded a telephone line was established and a regular station number given to the ship; thus putting her in direct communication with the company's office in New York, and with all other parties with whom the officers of the ship might have business.

The most serious railway accident of the week was a wreck caused by the collapse of a trestle near Hardentown, Ind., on the Cleveland, Cincinnati, Chicago & St. Louis Ry., Feb. 1. One car of a freight train was derailed and caused the collapse of the structure. Eight tramps were supposed to have been killed.——On Jan. 25 a passenger train on the Norfolk & Western R. R. was wrecked by running into a pile of rock which had fallen upon the track, near Riverton, Va. The train was composed of an engine, baggage car, four Pullman cars and a dining car. A Pullman car porter was killed and some of the trainmen were badly hurt. The wreck caught fire, and the baggage car and two of the Pullman cars were destroyed.

A locomotive of the North Pacific Coast R. R., engaged in pushing cars onto the ferry steamer at Sausalito, Cal., Jan. 28, was run onto the apron connecting the pier with the steamer, which gave way under the weight, throwing the engine into the water. The engineman was killed. The rules of the road forbid the running of engines upon the aprons.

An electric car of the Birmingham line, at Pittsburg, Pa., was struck by a car of the Duquesne line, at the crossing at Fourth Ave. and Smithfield St., Feb. 1. Both motormen claim to have had the right-of-way and to have sounded their bells.

A large derrick used in hoisting stone for the Walcott Building, at Indianapolis, Ind., fell, Jan. 27, owing to the loosening of a guy rope. It fell across the street, but, fortunately, nobody was hurt.

An explosion of boilers or dynamite, it is not definitely known which, occurred about 10:30 a. m., Feb. 3 at Lawrence, Mass. The accident occurred at the engine house on South Broadway containing the two boilers, two 25-HP. engines and an air compressor for work on the new sewer. Both boilers had the heads blown out, but this is said to have been the result of a primary explosion of dynamite cartridges which were being thawed, although, on the other hand, it is stated that blasting had been finished for the day. Two men in the employ of A. W. Byrnes & Co., the contractors for the sewer, were killed, and a great amount of damage was done by the smashing of windows and shaking of buildings.

The most disastrous boiler explosion of the week took place in the rolling mill of the Hollidaysburg Iron & Nail Co., at Hollidaysburg, Pa., on Jan. 30. Seven persons were killed or died within a day after the explosion, and several others are seriously, if not fatally, wounded. The boiler was of the plain cylinder type, 30 ft. long, placed over a puddling furnace, so as to utilize the waste heat. It had been repaired and tested 60 days before. When the boiler exploded it tore through the roof and landed about 200 ft. distant. One of the heads was blown a distance of 500 yards. Low water is mentioned as one of the most probable causes.

Dangers in the use of compressed acetylene gas have been discussed in a lecture by Prof. James M. Crafts, of the Massachusetts Institute of Technology, before the Society of Arts in Boston. If stored in a steel cylinder of 600 to 700 lbs. pressure, in the event of a fire in the building containing it it would be decomposed into carbon and hydrogen, and the latter would have a pressure of 20,000 lbs. per sq. in., which would burst the cylinder and cause great damage. A slight leak in the cylinder would be still more dangerous. Three or four per cent. of the gas in air would cause a mixture of terrible explosive force. Acetylene gas alone can be exploded by fulminate of silver, and the copper salts of the gas are also violently explosive. One danger in keeping gas in tanks in houses would be in the formation of a copper salt near the acetylene tank.

The coroner's inquest upon the three victims of the acetylene tank explosion, which took place in New Haven, Conn., on Jan. 21, resulted in a finding that the explosion was due to the rupture of a valve, causing gas to escape from the tank, and the ignition of the mixed gas and air. The valve was ruptured by the machinist using a 30-in. wrench upon it.

Gasoline engines are as safe as steam engines, but the gasoline tank from which they are supplied is as dangerous as a steam boiler. Such a tank exploded in the office of the "Daily News" in Salamanca, N. Y., on Jan. 27, wrecking the engine and setting the office on fire.

Boiler explosions during the past week have been quite numerous. As usual, sawmill boilers head the list. On Jan. 28 one exploded at Aquebogue, Long Island, N. Y.; no one injured. On Jan. 29 four boilers at the mill of the Southern Pine Co., at Offerman, Ga., exploded, wrecking the mill and killing seven employees, and on the same date two boilers at a sawmill in Centerville, Ala., exploded, fatally wounding two workmen. On Jan. 31 the boiler in a stavemill, near Freeport, O., exploded, wrecking the mill and killing three men, one of whom was thrown 300 ft.

The Street and Water Commissioners of Newark, N. J., have received another offer from the East Jersey Water Co. for duplicating the 48-in. steel conduit from the Macopin intake to the Belleville reservoir. The company states that it is about to lay a 42-in. conduit as far as Pompton Notch, and a 36-in. conduit the balance of the distance; also that for a strict compliance with the terms of the contract there would be required in addition a "small screw-jointed, lap-welded steel pipe alongside of the present 36-in. branch" from Belleville to the high service reservoir, this to be laid some time before 1900. The company offers, in place of laying the conduits mentioned above, to duplicate the 48-in. conduit "this year," provided the city will contribute $250,000 towards its cost. The company alleges that:

> We can show you by an inspection of bids received that it would cost the company precisely the same whether it builds a pipe of the above three several diameters from the intake to South Orange Ave., or the 48-in. pipe.

The propositon was referred to Mr. M. R. Sherrerd, Assoc. M. Am. Soc. C. E., Engineer of the Newark Water Department. Mr. Sherrerd advises that nothing should be done in the matter until a test of the original conduit under the nearest possible approach to actual contract requirements has been made.

Reports on a new water supply for Brooklyn have been made by Mr. I. M. De Varona, M. Am. Soc. C. E., Engineer of Water Supply; Mr. Wm. E. Worthen, M. Am. Soc. C. E., and Mr. Alfred White, late Commissioner of City Works. Messrs. De Varona and Worthen reported on a supply from the headwaters of the Ramapo, from the Housatonic and from a further extension of the present supply works on Long Island, the latter division falling to Mr. De Varona. Mr. De Varona has also made a separate report summarizing the plans and estimates for supplies from the three sources named. Mr. White reviews the work of the engineers and discusses other phases of a future water supply for Brooklyn. Mr. Worthen's Housatonic plan involves four reservoirs with a storage capacity of 19,235,000,000 gallons; 36 miles of duplicate supply conduit, about 60-ins. in diameter, of riveted steel, except the crossing of the Bronx River, Little Hell Gate and Hell Gate, between the mainland and Long Island; all at an estimated cost of $18,382,300 for construction, and $725,793 a year for fixed charges and operating expenses. Mr. Worthen's Ramapo plan includes 19 reservoirs, with 35,364,000,000 gallons storage; 39.2 miles of supply conduit, partly of 7-ft. tunnel, partly of riveted steel, and with the Hudson River and East River or Sound, crossing of cast iron; the metal conduits, two in number, to be about 60 ins. in diameter; all at an estimated cost of $14,630,200 for construction and $588,548 annual charges. Mr. De Varona's plans for the extension of the present Long Island supply includes eleven reservoirs, with a combined storage capacity of 400,000,000 gallons; 30.4 miles of duplicate 69-in. steel force main; several pumping stations, with elevated steel tanks; all at an estimated cost of $24,500,000, for construction, and $1,424,742 for fixed charges, of which $393,474 per year is the estimated cost of pumping. Mr. White seems to favor the Long Island plan, rather than either of the others. He expresses himself strongly against contracting with any private corporation for a water supply and speculates on the possibilities of a billion-gallon-per-day supply from the Delaware River for the Greater New York. The present supply of Brooklyn, Mr. De Varona estimates, will suffice for perhaps seven years to come, while an additional 100,000,000 gallons per day, making 214,000,000 of available supply, he thinks would do for 20 years longer. The average daily consumption of water in Brooklyn in 1895 was 80,124,342 gallons, or 79 gallons per capita for an estimated population of a little over 1,000,000 people.

The feasibility and cost of sand filtration for purifying the water supply of Pittsburg, Pa., is to be investigated by a commission, consisting of the Mayor, the President of the East Branch of the City Council and "eight representative citizens and taxpayers," two of whom shall be physicians, all of the eight to be appointed by the Mayor.

## A CONCRETE ARCH OF 40 FT. SPAN, AT BELLEVILLE, ILL.

The arch-bridge here illustrated is made entirely of concrete and it spans Richmond Creek in the city of Belleville, Ill. After examining plans for iron, stone, brick and concrete bridges which were proposed, the City Council finally decided upon either a brick or a concrete arch bridge, and proposals were invited for both. The bids received varied from $11,259 to $12,830 for a brick arch, and from $10,433 to $12,110 for the concrete arch, all of 40 ft. span. The latter, though the cheaper structure, was viewed with great suspicion by the City Council, both as to the feasibility of its construction and as to its durability. Mr. A. Geisel, civil engineer and contractor, of St. Louis, Mo., who submitted designs and bids for the brick and the concrete arches, finally proposed to build the bridge at his own cost and risk, without any compensation until the bridge was tested and accepted by the city as satisfactory. On these terms the contract was awarded to him for $10,500 for a concrete arch.

CONCRETE ARCH AT BELLEVILLE, ILL.

Designed and Built by A. Giesel, C. E., 204 Wainwright Building, St. Louis, Mo.

The ground upon which the bridge was to be erected was a black, soft soil saturated with water. Borings made showed no solid ground until rock was reached at a depth of 27 ft. below the creek bed. White oak piles were then driven to the rock, and were spaced 3½ ft. apart under the abutments and wing-walls. These piles were 12 ins. in diameter, 25 ft. long and were sawed off at a point 2½ ft. below the bed of the creek. The concrete trench was then dug out 1 ft. below the heads of the piles.

The concreting of the east abutment, including both wing-walls, was completed in seven days by two gangs of nine men each, mixing and placing concrete, and three more men erecting false works. The concrete was laid in 12-in. layers, thoroughly rammed over the whole area of both abutment and wings, and before a second layer was commenced the top of the first was well sprinkled so as to secure a good bond. In fact, the abutment and wing-walls were one solid mass of concrete.

The falsework under the arch consisted of 13 strongly-made centers, 4 ft. 4 ins. apart, resting upon four rows of six piles each and covered by 2x4 in. lagging laid loose on edge on the centers. Three days after the last layer of concrete was laid the molds were removed. To prevent trouble from the expansion of the falseworks by moisture, after the closing of the arch, the centers were kept wet before and during construction and covered with a layer of tar-paper. The skewbacks and both sides of the key were plastered smooth and also covered with a layer of tar-paper. The arch was thus made in three pieces, including the key, and each piece was free to contract or expand separately.

The arch is of 40-ft. span and 7-ft. rise; the total width is 52 ft., including 36 ft. of roadway between curbing and two 8-ft. sidewalks. Including the wing-walls the bridge is 85 ft. long, and the total height, from bottom of concrete foundation to top of roadway paving, is 24 ft. The arch itself is 2½ ft. thick at the skewbacks, increased to 2 ft. 9 ins. at the haunches, and decreased to 2 ft. at the crown.

The method of construction may be described as follows: On top of the retaining walls, on both sides, platforms for mixing the concrete extended the full length of the arch. For construction the arch itself was divided into five sections on each side of the key, and templates made to conform to each section were fastened to the centers for the full length of the arch and removed to the next joint after the concrete had set for three days. Owing to the strength of the concrete used, and to avoid imposing too heavy a weight upon the foundations, instead of a solid haunching, six 2-ft. walls were built, resting upon the arch and affording a solid support for the guttering and the street railway. The space between these walls was filled with clean clay made solid by ramming.

The wing-wall coping was in one piece, molded on the wall; and the coping and brackets above the arch were made of artificial stone molded in wooden boxes. These stones were covered with wet sand after they were taken from the molds and kept wet until laid in the wall. In this way the hair-cracks were avoided which commonly appear in artificial stone when exposed at once to the air and sun. The faces of the arch and wing-walls received four coats of plastering, the finishing coat showing alternate smooth and "rock-face" work. The iron railing is imbedded in the coping and parapets, and the sidewalks and combination curb were made of "granitoid." The roadway was paved with Mack's patent brick paving blocks laid on 9 ins. of concrete.

The arch radius was 32.07 ft., and it was made 1 in. higher in the center to compensate for any settlement after striking the centers. Five days after the arch was closed the wooden wedges under the arch centers were loosened to permit the arch to settle if it would. When the coping, railing and brick paving had been completed, the centers were removed entirely, and it was found that the arch had settled ⅝ in., which is chiefly ascribed to the settlement of the abutments and foundation piles under the full weight of the load. The four joints of the coping with the pilasters opened from 1-16 to ⅛ in.; but ten days after these joints were grouted and no further movement has been apparent.

Soon after completion the bridge was opened to travel, and two weeks later it was tested, as follows: Along the center line of the arch and covering an area of 15x30 ft., were concentrated four wagons loaded with macadam, one street roller and one electric street car weighing 68,000 lbs. in the aggregate, or about 151 lbs. per sq. ft. of loaded area. Careful levels were taken and showed no appreciable deflection under this load, though the load was left in place for two hours. When the bridge was formally dedicated, at least 1,000 people crowded upon it, hanging on the railing and standing on the parapets. This crowding was equivalent to an evenly distributed load of 100 lbs. per sq. ft. over the whole area of the bridge.

For the several parts of the bridge the following materials and proportions were used: For abutments, spandrel wall, haunching walls and concrete below roadway, 1 part Louisville cement, 3 parts Mississippi River sand and 5 parts of clean, crushed macadam. For the arch the same proportions were used, but Dyckerhoff German Portland cement was substituted for the Louisville cement. For the sidewalks, curb and gutters, Portland and crushed granite were used. For the coping, brackets and exposed parts of the parapets, a stiff mortar of 1 part Portland cement to 2½ parts of sifted crushed granite were employed. The plastering was done with 1 part Portland cement to 2 parts of sifted Meramec sand, and for the rough surfaces 1 Portland cement and 2 parts fine gravel. Mr. Geisel, who has had long experience in concrete work, says clean gravel will answer as well as macadam; and all the labor involved, aside from superintendence, is of the ordinary class. The success of this work, combined with its relative cheapness and handsome appearance, is worthy of study by town and county authorities. But it would also be well, in deciding upon concrete, to have the work executed under the superintendence of some one, like the builder of this bridge, who had sufficient confidence in his own experience and ability to make his compensation dependent upon absolute success.

## THE BETTER MAINTENANCE OF HIGHWAYS IN THE TOWNSHIP OF EAST ORANGE, N. J.*

By William S. Bacot, M. Am. Soc. C. E.

The maintenance of a high standard of excellence in the highways of suburban towns is a more difficult task than the care of the paved streets of cities. An ordinary suburb can only afford telford or macadam paving, good material for which is often not at hand or is expensive to obtain, while the roads are called upon to meet every requirement of extremely variable traffic and every exigency of wear and weather. In the township of East Orange, however, all unfavorable conditions are reduced to a minimum, and there is no reason why the street system should not be perfect, and yet, with all deference to those officials whom the taxpayers have placed in charge of road affairs, it is my judgment that we are not receiving benefits commensurate with the rate of taxation.

The amount of money that the Township Committee has been appropriating from year to year is entirely inadequate, and is simply dissipated when spread over the township. The amount is from $15,000 to $20,000 per year, and this year it was $18,000, of which $5,000 was consigned to the usual annual sacrifice on Main St., in the futile effort to keep pace with the terrific wear and tear on the telford paving. Only about $4,000 have been used in repairing streets outside of Main St. and in making general repairs and the odd jobs that require instant attention from day to day.

The street department consists primarily of a Commissioner of Streets and Sewers, who is also the township engineer, and is paid only $1,800 a year. Subordinate to him in the street department is the Road Overseer, who is elected by the people, and acts simply as the foreman of the gang of road laborers, and is paid $2.50 per day. The labor force varies from 5 to 20 men, and about five men do constant duty cleaning streets and on odd jobs when not otherwise employed. The laborers are hired at $1.50 per day. Carts are furnished at $3.25 per day, with driver, and teams at $5 per day, with driver, all being paid for per hour of actual time. This corps, together with a five-ton horse roller and an outfit of common tools, constitute the street department, and I consider this department to be inefficient, inadequate and devoid of organization. The general repairs made to some of the streets are quite up to the old standard; the patchwork done on others is

* Abstract of a paper read Dec. 14, 1895, before the Improvement Society of the Township of East Orange, New Jersey.

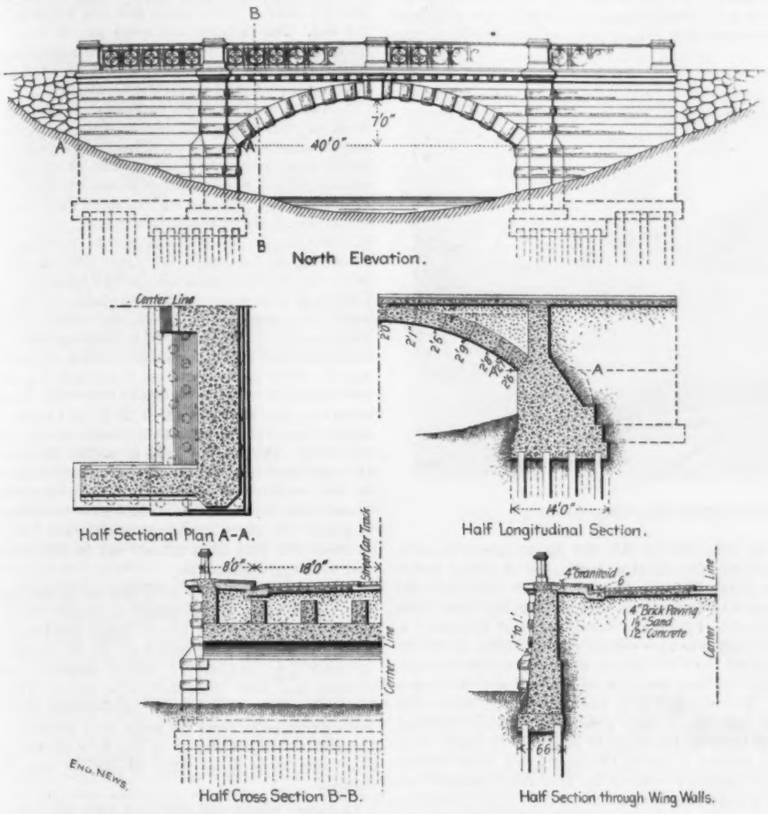
too meager to merit more than passing notice; street cleaning marks the departure of the snow and the falling of the leaves. These sum up about the results we have netted from our street department, and I think it is as much as we have a right to expect. The commissioner is poorly paid, has insufficient resources, has a crippled force of pensioners to botch work that ought to be done skillfully, and is bothered and badgered by the interference and nonsense of those who imagine they have claims upon his obedience by virtue of his appointment. Special criticism should be directed against the Township Committee, which is directly responsible for the system of street maintenance now in existence.

In my opinion the best results would be obtained by placing the department in the hands of a single commissioner (not an appointee of the Township Committee), who should be an energetic man and an engineer of experience, giving him full power and means to carry out the proper purposes of his office independently and free from interference, and then holding him to strict accountability for his official acts. He should have an assistant (at about $1,000 a year) to give lines, grades, etc., on street and sewer work, and an assistant in charge of road repairs and street cleaning; also other helpers, instrument men, etc., as occasion may demand, but not regularly employed unless the amount of the work warrants the expense. The laborers should be hired directly, and organized on the basis of a limited block system, with a central working force to cover territory not included in the block system. (This system of organization was described in Engineering News, Dec. 6, 1894.) In East Orange there should be a block man to each two-thirds of a mile of road, which piece of road he could keep clean and in order, making light repairs, restore the surface after it has been broken by excavations for water or gas pipes, etc. Each man should be provided with a barrow or push cart, short square shovel, street broom, large hoe, rake, pick and iron tamper, and should wear a suitable uniform. There should be 15 of these men, and the equipment would cost about $10 per man.

The township has about 50½ miles of streets, and is charged with maintaining 30 miles of improved streets. The maintenance of 10 miles of these 30 miles would be attended to by the block system, which, however, does not include the general repair of the roads at intervals of about five years. The object of the central force, already referred to, is to care for, clean, and repair, at frequent intervals, the remaining 20 miles, and to make general repairs on the whole 30 miles. For street cleaning and light repairs it would be advantageous to divide this force into several small gangs under separate foremen (who would work with their gangs), and to assign them to separate districts. With a surface wear of ½ in. per year, the thickness of the road coating would be reduced 2½ ins. in five years, and renewal should then be attended to, this being done by a larger gang of the central force. This force would also lay crosswalks, repair gutters, basins, drains, etc., and do necessary ditching. Its equipment should include a 10-ton steam roller ($3,000), a 600-gallon sprinkling wagon ($350) and the usual accessories and outfits of working tools.

In regard to the existing roads, the form is absurdly high, and in many cases it is too flat to shed water. Excessive crowning confines the traffic to the center of the street, and has the same effect as narrowing the wheelway, besides making it awkward for passing vehicles or for carriages drawing up to the curb. The block gutters are generally laid with too steep a slope. In most cases the exposure of the curb is too deep, sometimes 10 to 12 ins., while 6 ins. would be sufficient. All curbs and gutters should be laid in sand. The gullies that cross some of the principal streets at intersections are a nuisance, but as there is no main drainage system in the town, there appears to be no remedy but to make them as easy as possible. Main St. presents a case for special treatment. The lines of travel on each side of the electric railway tracks make two ruts and a furrow where the horses strike, and it is found necessary to repair it every year. Under the circumstances it might be better economy to lay a sheet asphalt pavement, with a guarantee for 10 or 15 years, than to go on paying from $4,000 to $12,000 a year for maintenance and still never have the street more than passably good. There are also areas about railway stations and spots similarly frequented where asphalt would be very desirable.

Street sprinkling, as it is now practiced by private parties, tends to make the roads wear faster. It should be under the control of the Street Commissioner, and excessive sprinkling and drenching of the roadbed should be prevented. Street opening for water, sewer or gas pipes and other purposes, should be subjected to the directions of the commissioner, no pavement being disturbed until a permit has been granted, and no permit being granted unless a deposit is made with the commissioner, conditioned on the proper restoration of the roadbed and road surface.




DETAILS OF BELLEVILLE CONCRETE ARCH BRIDGE.

The U. S. gunboat "Helena," a duplicate of the "Wilmington," was launched, on Jan 30, from the Newport News yard. The "Helena" is 250 ft. long and 9 ft. draft, has 1,400 tons displacement and a speed of 13 knots. She is especially intended for river service and will be armed with eight 4 in. rapid-fire guns, and eight smaller rapid-fire guns and two gatling guns. The contract price is $280,000.

## THE BEAR RIVER IRRIGATION SYSTEM, UTAH.

By W. P. Hardesty, C. E.

(With inset.)

The Bear River canal system is designed to irrigate the delta valley or plain of Bear River, shown in the map, Fig. 1, located in northern Utah, on the northeastern side of Great Salt Lake. The river cuts through the range of mountains on the line between Box Elder and Cache counties, by a narrow canyon and flows south through Box Elder County, discharging into Great Salt Lake. The valley is traversed by two railways, the Utah & Northern, which runs along the east side, and the Central Pacific, which traverses the southeast and south parts. Its most important town and center of the irrigation system is Corinne, 24 miles northwest of Ogden and on the Central Pacific Railway.

The source of the Bear River is in the Uintah Mts., about 50 miles east of Salt Lake City, but it has a long and tortuous course, first north into Wyoming, then back into Utah again, then back into Wyoming and on through southeastern Idaho, forming here a half circle and returning nearly directly south through Utah to the lake. It is an exceptionally well fed stream, having a drainage area of 6,000 sq. miles. It flows through the Great Bear Lake, lying in Utah and Idaho, and this tends to equalize the flow, acting as a reserve for maintaining the volume during the low water period.

A U. S. Geological Survey gaging station has been established at the mouth of the canyon since June, 1889. Following is the average monthly flow at the same from June, 1889, to the end of 1892:

| | Cu. ft. per sec. |
|---|---|
| January | 1,234 |
| February | 1,172 |
| March | 2,330 |
| April | 3,360 |
| May | 5,454 |
| June | 4,022 |
| July | 2,053 |
| August | 1,076 |
| September | 960 |
| October | 1,160 |
| November | 1,175 |
| December | 1,262 |

This gives an average flow of over 2,100 sec. ft., and it is seen that the supply is well kept up in the three irrigation months of May, June and July, when water is most in demand.

Surveys have shown that by a low dam a few hundred feet in length, Bear Lake can be greatly increased in capacity, and made to store a supply for the low-water period.

The delta plain before spoken of contains some 200,000 acres of excellent arable land, which needed only water to make it highly productive and valuable. Prior to 1889 no attempt had been made to use the water of the river to any extent for this irrigation, for the reason that the river, after its descent from the canyon, lies in a deep gash cut in the plains, with little fall, making it impossible to get water out to the plains unless taken from the head of the canyon. In that year the Bear Lake & River Water-Works & Irrigation Co. was organized, with a capital of $2,100,000. Mr. Fred Mathyas was the chief engineer, and the preliminary surveys as well as the design for the dam and location of all the lines through the canyon are due to him.

The descent of the river in the two miles of canyon is over 100 ft., there being many rapids and one fall of about 14 ft., while both above and below the canyon the stream is quite sluggish.

The dam was located at the head of the canyon in order to secure as great an elevation as possible, here 172 ft. above Great Salt Lake. The general plan was to construct a canal on each side of the river, carrying them on supported grades around the sides of the valley, covering all the land possible, as shown by Fig. 1. The company also had for its object the supplying of the city of Ogden with water for domestic use, but this is entirely distinct from the works now being described.

The dam is 370 ft. long and of a maximum height of 17½ ft., maintaining nearly that height for the full length. A view of the structure is shown by Fig. 2, while Fig. 3 shows a cross-section and partial elevation. It is a crib dam of 10 × 12 in. timbers, with spaces filled with stone. The timbers are spaced 4 to 6 ft. apart, are drift-bolted together, and the dam has a slope of ⅛ to 1 on its face or down stream side and 2 to 1 on its back. The five bottom layers are level; for the remainder the cross timbers are laid with the slope of back of dam and the longitudinal timbers on these at right angles. The

back of the dam is made plumb for 6 ft. 5 ins. from the bottom, then given the slope forward of 2 to 1. A heavy layer of earth is put on the back over the double cover of 2-in. plank to shut off the flow of water through it as nearly as possible. The water falls on a platform or apron of two layers of 3-in. plank nailed down to the mud-sills extended in front. The mud-sills are 12 × 12-in. timbers, and are drift-bolted to the rock bottom with bolts 1¼ ins. by 3 ft., four to each sill. For about 125 ft. in the middle of the stream this apron is replaced by a layer of 10 × 12-in. timbers, drift-bolted to the sills.

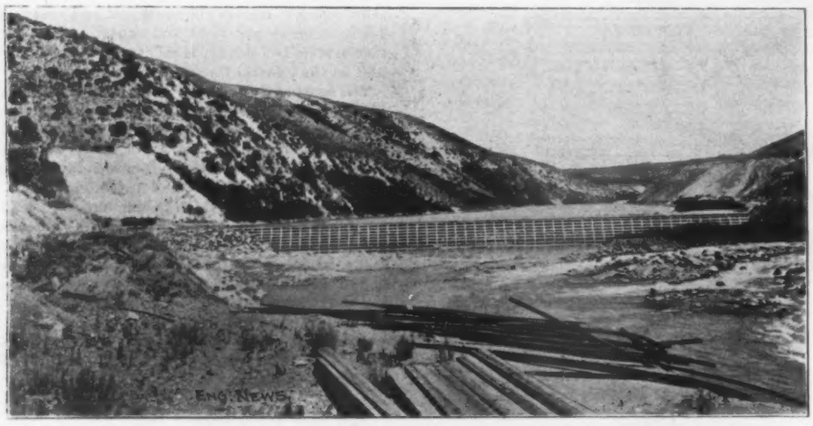



Fig. 2.—VIEW OF DAM, BEAR RIVER IRRIGATION SYSTEM, UTAH.

The apron is 7 ft. 10 ins. broad, and the total length of the mud-sills is 38 ft., this being the extreme width of the dam.

The dam has stood well except for about 100 ft. at the west end. This part had been founded on gravel and boulders and not on solid rock, and in the spring of 1891 it was under-scoured badly to a depth of 15 ft. in places. Chief Engineer Fortier, then in charge of the system, protected the ends of the washout with a combination of bundles of brush bound with wire, rock and old rails, and thus saved the structure until low water allowed it to be repaired. The river was then diverted by a coffer-dam and two rows of sheet-piling, one at the back and the other 4 ft. up stream from it, were driven well into the bottom, the space between being filled with concrete. The back of dam was then well covered with earth again, and boulders were piled up in front, partly shown in Fig. 5, nearly to top for part of the break, to reinforce dam. These were thrown in roughly and given a slope of about 3 to 1 on the down-stream side. These repairs cost $4,700 and no trouble has been had with the dam since then. The dam backs the water up into the Cache Valley about three miles. The two canals, called East Canal and West Canal, head at either end of the dam.

East Canal.

The East Canal has been constructed but a portion of the way and was never put in condition for service. It was opened and about 90% of the earth and rock work completed to the end of Sec. 8, at Sta. 379, about 7¼ miles. The head gate, flumes, etc., have not yet been built. The grade for the first ¾ mile is 2.12 ft. per mile, then 3.62 ft. for 1½ mile, then 2.12 ft. to Sta. 379.

The bottom widths for these grades are 18 ft. and 14 ft., respectively, and the depth of water to be carried is 10 ft. The slopes of cuts in the canyon for both the East and West Canals average ¼ to 1, and not over ½ to 1 in earth. The estimated safe capacity of the canal is 800 cu. ft. per sec.

The bottom of this canal at the head-gate is to be just 10 ft. below the top of the dam. The excavation for this has already been done, and during low water the river at present passes this way into the canal and into its bed again by a short cut just below the dam. Through this narrow opening, but about 20 to 25 ft. wide, about 2,000 cu. ft. per sec. passes when the water is just even with top of dam, and during lowest water (over 1,000 cu. ft. per sec.) the water lacks over a foot of being to the top.

About five miles of the canal is steep hillside work, and the two miles in the canyon is extremely difficult. The Utah & Northern Ry. runs through the canyon but a short distance above the canal and has here its most expensive work. The railway has two trestles, one 75 ft. high in the middle and nearly 300 ft. long, and the other 90 ft. high and 400 ft. long; has one tunnel 300 ft. long and also several stretches of high retaining walls.

The canal is in rock-cut or tunnel all the way here, except where flumes are to be used. There are two tunnels, with lengths of 197 and 423 ft. At four miles from the head Beaver Dam gulch is crossed. Here is a fill 400 ft. long, 115 ft. high in the middle at outer toe for 35 or 40 ft. and containing 168,900 cu. yds.

From Sta. 370 to 374 the banks are gradually lowered and the canal widened, the depth of water to be reduced from 10 to 7 ft. Beyond Sta. 379 the line was located as far as Hot Springs, eight miles north of Ogden, a total length of 44 miles. A preliminary was also run on to the Ogden River, in the north part of Ogden, over 6½ miles farther. This preliminary was run on a grade of 1.056 ft. per mile. The located line had grades of 0.528 to 1.584 ft. per mile; the bottom was to have widths varying from 20 to 50 ft., the bank to be 9 to 11 ft. high, with an 8-ft. crown, in order to carry 5 to 7 ft. of water, and the capacity was to be gradually lessened as laterals were taken out.

West Canal.

The West Canal runs on the west side of canyon and valley. It is the one completed and put in operation, and under which farming has been going on. The country encountered in the canyon is very similar to that on the east side. For the five miles of hillside work before getting out to the bench or table land the grade is 3.62 ft. per mile in the canyon in rock, and 2.12 ft. for the remainder, the bottom width 14 to 16 ft., the depth of water 10 ft., and the estimated safe capacity 800 cu. ft. per sec.

As shown by the details, Fig. 4, and the two views, Figs. 5 and 6, the head gate is entirely of steel, with masonry abutments, and consists of five gates, 4½ ft. in clear width, with 10 ft. lift. Each gate has a screw-stem with cog-wheel on it, and this is turned by worm gearing and the gate thus lifted. The gates were built by the Lane Bridge & Iron Works, of Chicago, Ill. Mr. W. H. Rooney is the Chief Engineer of the company, which also furnished the iron work for all the other large gates on this system.

The floor of the gate is 10.31 ft. below the top of the dam. Leading from the gate to the first cut is a flume 128 ft. long, shown in Fig. 6. The width is 32 ft. at the gate; this is reduced to 12 ft at 80 ft., the taper being all on the stream side; then follows 32 ft. of straight or regular flume, attached to which is the 16-ft. approach and apron, with wings flaring to 28 ft. The 32 panels of the flume are each 4 ft.

A bent or "yoke" consists of the 10 × 10-in. sill, the 8 × 12-in. × 14-ft. posts, and the 4 × 12-in. tie at the top. The bottom and sides are of 3-in. plank, clear depth 12 ft. Over 31,000 ft. of lumber was required for this flume, and a portion of the lower side is supported by a masonry wall.

A number of tunnels carry the water through some of the bolder rock points with perpendicular faces. In the longer of these here, as well as on the East Canal, advantage was taken of the gulches crossed, where the tunnel came near to the surface or opened out, to carry on the work each way from these also. All tunnels were in rock and required no timbering. The width is 14 to 16 ft., height 10 ft. to springing line, with elliptical arch at the top. Six tunnels, one 312 ft. long, with an aggregate length of 1,139 ft., were put through on the west side. At about 1,200 ft. from the head is the first waste or overflow gate for discharging water back into the river, through a flume, shown in the view, Fig. 7. This gate is at the lower end of a tunnel, one mouth of which is shown in the view. The falls shown in the view are 12 to 14 ft. in height. The waste from the East Canal is shown on the right of the view. The second gate is about 600 ft. below this and just below it are the secondary head-gates in the main canal, shown by Fig. 8, for stopping water here when desired. Each gate (or rather set of gates) has three openings, with gates 4 ft. wide in clear and with 10 ft. lift, all set in very substantial masonry abutments.

A number of masonry retaining walls are used on the lower side of the canal, in place of an embankment, where the latter could not be made to hold. These have top width of 2½ ft., batter of ¼ on each side, and are of rubble masonry laid in cement and well plastered with same. They are used in many places, and particularly wherever there are gaps to close between rock points, as was the case at tunnel shown in Fig. 9, or between rock and wood-work, as at ends of one or two of the flumes.

In places where one end of a wall adjoins earth, it is flared out at that end to allow a good bank of earth to be placed on the inside and tapered to the bottom at the further end to give as long a contact as possible. It has been found difficult to make an embankment stand on the steep hillsides of the canyon, as when well soaked by water from the canal it tends to slide bodily. Only two flumes in the canyon, the one at the head and a 98-ft. flume further down, were built at first, but several others have since been put in. Fig. 10 shows the 98 ft. flume, the sides being carried only part way up, to answer present needs for supply. It is located on a curve of the canal. Nearly 20,000 ft. of lumber were used in it. Only a natural rock or compact earth bank, as secured in the deep cuts, has been found entirely satisfactory for lower side of canal in the canyon. The canal has never been called on to carry more than 3 ft. of water yet, and when the full depth of 10 ft. is required some alterations will likely be needed.

In the spring of 1891 water was first turned into the canal for irrigation, only the first two miles

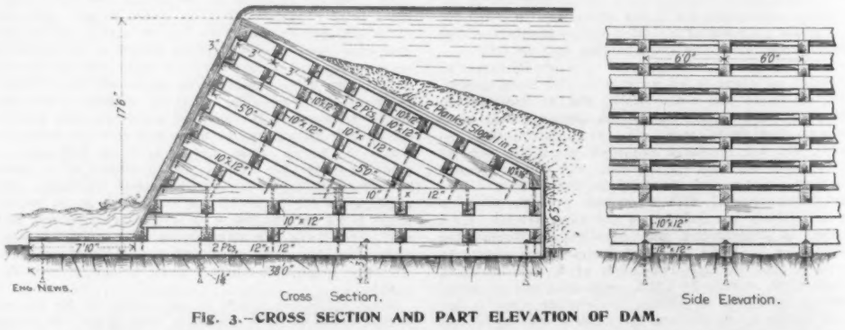



Fig. 3.—CROSS SECTION AND PART ELEVATION OF DAM.

having been covered by it before. During the first season much care had to be used on the canal on the steep hillsides below the canyon. Several slides occurred, and on the night of July 3 over 20,000 cu. yds. of earth slipped down into Bear River. Portions of this slide moved over 800 ft. horizontally by 100 ft. vertically.

The most effective method tried by Chief Engineer Fortier in preventing slides was to procure cattle and horses (sheep could not be had at that time), and after the bottom of the canal was moistened the animals were driven back and forth over the

Fig. 9.—View of Masonry Retaining Wall at Tunnel Entrance on Main Canal.

same for hundreds of times. A mixture of puddled clay and gravel was then placed by hand near the bottom of the slopes and the water turned in. No more trouble was had with portions so treated. The portions that gave way were replaced by flumes. All the weaker portions were found and effectually repaired the first season.

At one gulch crossing, instead of a flume a half-flume was used. This consisted of a wall of boards with posts carried well below grade on lower side of canal, with earth embankments built around it and imbedding it; the bottom of gulch was filled up to grade and the proper embankments built to give the regular cross-section of canal. The board wall was covered by inner part of lower embankment, which acted as a puddle to keep water away.

Nearly all the excavation in the five miles of canyon work required blasting, a hard shale being encountered after solid rock was left. This, however, softened and became rather slippery when wet. There is one 90-ft. rock cut with several 35-ft. earth cuts, all on the upper side. The canals were located according to railway precedents or ideas, having regular curves and tangents, which was one of the causes of such heavy work in the canyon where a contour or grade-line following the steep hillsides closely must needs be quite tortuous, though a slight deviation from same causes a heavy cut or fill.

Work was begun in the fall of 1889 and prosecuted with much vigor until about Jan. 1, 1890, when dissensions in the company caused a shut-down and resulted in a change of management. Work was begun again in the spring with Elwood Mead (then Territorial, now State Engineer of Wyoming) as consulting chief engineer, J. C. Ulrich (Chief Engineer of the Traveler's Insurance Co.'s canals in Colorado) as engineer in charge of all work. The iron head-gates were designed (in general plan) by Mr. Mead, and also the two large iron flumes described further on. Mr. Ulrich located the canals out on the bench land and designed many of their structures, having originated the standard types of flumes, drops and head-gates used by the company. Mr. Ulrich had charge from April to November, 1890.

All but about 125 ft. of the dam, this lying in the middle of the stream, had been completed in 1889, but this section was not put in until Feb., 1891.

At one time as many as 7,000 names were on the pay-rolls on the work, and 22 men were killed in the canyon work. The contractor for the canyon work was Mr. Wm. Garland, now of Los Angeles, Cal., while Corey Bros., of Ogden, had the canal work on the bench on the west side. The prices paid were: Solid rock, 70 cts. per cu. yd.; loose rock, 28 cts.; earth, 7½ cts.; tunnels, $3.50 per cu. yd.

After gaining the top of the bench the West Canal turns to the northwest, up the valley of the Malad River, and runs so for three or four miles until the river is crossed, when it runs south and southwest. At about one-half mile from the top of the bench the canal is divided, the Corinne Canal being thrown off here and running nearly south on the gentle divide between the Malad and Bear River Valleys. At this division two substantial sets of gates are placed, shown by the view, Fig. 11. The gate frames are shown in detail by Fig. 12. Each consists of six gates with openings of 4 ft. wide and with 7 ft. lift. These are all of the same model, with built iron posts and slides between gates and iron hoisting apparatus, a winch with horizontal axis turning by beveled gearing the screw shaft which lifts the gate.

The structure for each set of gates is founded on 30 12-in. round piles, 10 ft. long, and contains over 16,000 ft. B. M. of lumber, not including that in the gates themselves, which are made up separately. The main canal from the top of the bench to these gates is in a heavy cut with 16 ft. bottom and slopes of ½ to 1, intended to carry 10 ft. of water. The canals on the bench, where the surface is nearly level, require a bank on each side, whereas in the canyon and all hillside work of any considerable transverse slope only the lower bank is required. For most of the work on bench, the slopes are as follows: Cuts, 1 to 1; inside of banks, 2 to 1; and outside, 1½ to 1. A berme is also generally left between the cuts and bank to keep dirt from falling in, and also to permit of widening. From the division gates on the extension west for 3½ miles the bottom width is 26 ft., fall 1.056 ft. per mile, and depth of water to be carried 7 ft.

(To be concluded.)

## DEFECTS IN THE NEW YORK SPEEDWAY.

The report upon the Harlem River Driveway was made public on Jan. 30, by the board of experts appointed to examine the work done. These experts were Mr. Theodore Cooper, Prof. W. H. Burr, of Columbia College, and Mr. James J. R. Croes. The defects in construction treated of in the reports are mainly in the 2,300 ft. of retaining wall built upon cribs and lying between 155th St. and High Bridge. About 300 ft of this cribwork has slid out into the river from 3 to 8 ft. at the top, and the arch of a subway, under the drive and near High Bridge, shows a crack 2 ins. wide in the arch. In treating of this subway the experts find that the retaining wall was built upon piles, 70 ft. long, driven into soft mud to sloping rock; the floor of the subway rests upon shorter piles and the only bond between the two is the arch itself. The contract called for a grillage of timber, binding the piles together, and a row of 78 brace-piles upon the river side of the retaining wall. The engineer in charge for the Park Department did not enforce these provisions, and failure is the result. The failure of the cribwork is ascribed to the want of any borings, or investigation into the character of the bottom soil. It was assumed that cribs extending 18 ft. below low water would be sufficient to provide for the 15 ft. of water required in the ship canal, and construction was commenced upon this basis. But it was soon found that the soft mud extended 27 to 30 ft. below low water, and to an apparently hard stratum. As the grade of the driveway was on this section from 8 to 12 ft. above high water, the result was a crib from 40 to 48 ft. high on a base 33 ft. wide; an unstable condition that resulted in bulging. In both this case and in that of the subway the contractor is exonerated, as the work was done on the lines laid down by the Engineer. The experts recommend that so much of the crib as has slid out be removed and rebuilt. The roadway is also sinking in many places, and this is ascribed to careless filling with large stone, leaving space for the entrance of river water and the gradual washing out of the finer material beneath the roadway. This trouble, say the experts, can be remedied by stripping the top of the present fill down to the rock filling, and thoroughly filling the voids with gravel and small stones; no tentative method of filling from the top will give any reasonable expectation of success. The report says that the main causes of all the trouble are undue haste and a lack of previous investigation into existing conditions and the want of proper plans. Haste in the execution of the first contract with Mr. James D. Leary has already added $39,000 to the original contract in the form of extra work. What these repairs will cost in addition is not included in the present report.

## ECONOMICAL RESULTS IN AN ISOLATED ARC LIGHTING PLANT.*

By F. E. Drake.

Much has been said and written about economies which might be practiced in isolated lighting plants, but as yet very few actual data have been presented to the public upon the cost of operating an isolated arc lighting plant, and showing what might be done with modern machinery if properly installed and then operated by careful and competent hands. The plant which is the subject of this paper is that used to light the handsome store of J. L. Hudson, a clothier in Detroit, Mich. The electric plant as installed consisted of five Standard arc dynamos of 40 lights capacity each, 205 Standard double service arc lamps, and a 200 light direct-current 110-volt dynamo, wired for full capacity. The plant was started Sept. 1, 1891, and has been operated every working day since.

By courtesy of Mr. A. F. Chappell, Chief Engineer, who has been in charge of the plant since its completion, an itemized account of the operating expenses has been furnished the writer. The record is in detail for the full period of four years and four months from Sept. 1, 1891, to Jan. 1, 1896. Time and space is too limited to show the detailed record for each year, but for a comparative basis the expense for the year 1895 is given.

In arriving at the average cost per lamp the 200 incandescent lamps are computed as the equivalent of 20 arcs. Each arc lamp is adjusted to 50 volts, and the dynamos being wound for 10 amperes, each are therefore consumes 500 watts. The following table shows the record of output:

| | For 4 years and 4 months. | For year 1895. |
|---|---|---|
| Arc lamp-hours | 1,527,538 | 351,658 |
| Arc K. W.-hours | 763,769 | 175,829 |
| Incandescent lamp-hours | 2,735,766 | 1,038,836 |
| Incandescent K. W.-hours | 150,467 | 57,136 |
| Cost per K. W.-hour | | $3,145 |

In reviewing the cost per lamp for 1895, it will be noted that the three chief items of expense are $13.79 for labor, $9.71 fuel and $2.75 for carbons, figures which are quite phenomenal when the output is considered.

Perhaps the most startling figure shown is the extremely low cost of dynamo and lamp repairs. In 1895 the total of dynamo repairs, including brushes, was $30.85 or $5.14 per dynamo. Can a better showing be hoped for? The 205 arc lamps had repairs to the extent of $85.90 or 42 cts. per lamp, which covered all globe breakage.

Instead of giving the lighting plant credit for exhaust steam at its estimated value, Mr. Chappell has made the set-off by reducing the depreciation percentage on the engines and shafting, and the interest charges on a sum placed at $6,000, which the owner, after several years' experience, testifies to as being fair and equitable.

COST OF 205 ARC AND 200 INCANDESCENT LAMPS IN THE J. L. HUDSON BUILDING, DETROIT.

| | For entire period of 4 years and 4 months. | For the year 1895. | Cost per arc lamp, 1895.† |
|---|---|---|---|
| Coal | $8,834 19 | $2,185 70 | $9 71 |
| Carbons | 2,979 31 | 618 00 | 2 75 |
| Labor | 14,012 09 | 3,102 43 | 13 79 |
| Water for boilers | 452 09 | 86 00 | 38 |
| Soap, soda, mops and brooms | 128 76 | 12 35 | 06 |
| Cylinder, dynamo and engine oil | 1,004 28 | 181 74 | 81 |
| White waste | 165 15 | 29 82 | 13 |
| Incandescent lamp renewals | 807 85 | 110 33 | 49 |
| Incandescent wiring | 422 50 | .... | .... |
| Repairs on boilers and furnaces | 794 66 | 311 33 | 1 38 |
| Repairs on clutches and shafting | 41 85 | 8 31 | 03 |
| Repairs and packing for engines | 110 26 | 45 36 | 20 |
| Repairs on 205 arc lamps | 163 02 | 85 90 | 38 |
| Repairs on 6 dynamos, including brushes | 1335 44 | 30 85 | 14 |
| 10 % depreciation on boilers, $2,000 | 866 66 | 200 00 | 88 |
| 2 % depreciation on engines and shafting, $1,000 | 346 66 | 80 00 | 36 |
| 4 % interest on $6,000 | 1,000 00 | 240 00 | 2 07 |
| Total | $32,464 77 | $7,328 12 | $32 56 |

*Slightly condensed from a paper read before the Northwestern Electrical Association.

†$200 of this sum expended in changing one of the 40-light arc dynamos for a 50-light machine.
Average in last column on basis of 225 arcs.

The New Jersey Road Improvement Association, at its meeting at Trenton on Jan. 28, adopted a resolution recommending the purchase of turnpike roads owned by corporations, and their improvement under the State Roads act, the funds to be furnished by the state, the county and the abutting owners, in the proportions laid down in the State Aid act.

## A DIPPER DREDGE FOR DIGGING PHOSPHATE ROCK.

We illustrate herewith a light draft dredge which has been designed by the Vulcan Iron Works, of Chicago, Ill., for handling phosphate rock, and which will soon be put at work in the phosphate mines near Albion, Fla. Practically the same size and style of dredges have recently been built for digging drainage ditches in Indiana and Illinois, where they are stated to have shown a capacity of 800 cu. yds. in eleven hours, or about 73 cu. yds. per hour. It is expected that the dredge illustrated will handle from 50 to 70 cu. yds. of phosphate rock per hour, but as it has not yet been put at work, it is not known exactly what it will do.

The hull of the dredge is of wood, 65x24 in., with drafts of 4¼ ft. forward and 4 ft aft. The framework consists of side trusses, 15 ft. 4 ins. high, made up of 5x10-in. timbers, and braced together by timber laterals on top. To steady the dredge while working, there are three spuds, two 12x12 ins., oak, at the forward corners of the hull, and one 10x10 ins., oak, at the center of the stern of the hull. These spuds can be operated either by hand or power. The power hoist consists of a steam cylinder fitted with a piston-rod attached to a grip casting. When the steam is admitted under the piston it will grip the spud and raise it from the bottom. It is then caught by the dogs on the spud shaft and held fast while the steam is exhausted and the piston drops to take hold of the spud again at the bottom of the stroke.

DIPPER DREDGE FOR DIGGING PHOSPHATE ROCK.*
Capacity of Dipper, 1 cu. yd. Vulcan Iron Works, Chicago, Ill., Builders.

The crane is hung to a steel mast bolted to the framework. The mast is 17 ft. high and the crane tip raises 10 ft. above its top or 27 ft. above the footing. From the mast to the crane tip the horizontal distance is 32 ft. and the angle of swing is 180°. The crane is built of wood and the style of its trussing is clearly shown by the illustration. The dipper handle is of oak, 5x12 ins. x36 ft., and the dipper is of steel and Ulster iron and has a capacity of 1 cu. yd. The swinging circle is of steel, 14 ft. in diameter, and is attached to the top of the mast. The power is conveyed to the swinging circle by means of a ¾-in. Ulster iron chain.

The machinery consists of a double cylinder, 8½ x12-in. engine, with swinging, hoisting and backing drums. These drums are driven by gearing from the engine shaft and are controlled by friction clutches. The hoisting and backing drums are 12 ins. and 8 ins. in diameter respectively, and the hoisting chain is ⅞-in. The total weight of the machine is about 5 tons. Steam is obtained from a 48 ins. x 12 ft. 8 ins. 40 HP. tubular boiler of the locomotive type. We are indebted to the Vulcan Iron Works, of Chicago, Ill., the builders, for the illustration reproduced herewith.

## TILE DRAINAGE IN INDIANA.

At the Annual Convention in 1895, of the Indiana Engineering Society, Mr. James L. Romack presented a paper upon tile drainage, from which the following is abstracted:

There are said to be 524 establishments in Indiana and 670 in Ohio, turning out annually about 14,000 miles of drain tiles in the aggregate. At an average cost of 60 cts. per rod, more than $2,750,000 is spent each year in these two States upon these tiles, assuming that they are all used within these States.

The size of the tile to be used will, of course, depend upon the rainfall, the area to be drained, quality of soil and the gradients adopted. Mr. Romack recommends the following sizes of tiles to be used in Indiana: An 8-in. tile with a fall of 1-10 ft. in 100 ft., with laterals, will afford a sufficient outlet for 40 acres of land; a 10-in. tile, with the same fall and conditions, will make a good outlet for 80 acres; a 12-in. tile for 160 acres; a 15-in. tile for 350 acres, and an 18-in. tile will make a sufficient outlet for 600 acres. All tile 10-in. or larger ought to be not less than 2 ft. long. When laying 15-in. or 18-in. tiles in a ditch not over 5 ft. deep, it is better not to cover with more than 3 ft. of earth at first. Allow this to thoroughly settle before putting on more earth, as large tiles are liable to break and stop up under heavy loads, carelessly applied.

Large tile ditches should be at least 8 ins. below the grade of the laterals, even at the sacrifice of some fall in the main ditch. The open ditch at the end of an outlet system should be at least 1 ft. lower than the outlet tile, and a stone wall should be built at this outlet. This wall should be at least 4 ft. high, 2 ft. thick, and be started 1 ft. below the bottom of the lower ditch and be long enough to hold the embankment. This prevents the earth from washing off and filling the open ditch. One joint of regular sewer pipe should be used at the terminus of the drain. All timber ought to be killed for a distance of at least 20 ft. on each side of a tile drain, to prevent the fine roots from entering the joints. One row of 12-in. tile is better than two rows of 10-in. tiles side by side, as shown by experience in laying and in use.

Ditches in "black soil" should not be less than 3½ to 4 ft. deep; they will drain farther, give a deeper bed to plants and cereals, be less subject to trouble from freezing and drouth and afford a greater bed for absorbing heavy rainfalls. On clay soil, not so porous, 2½ ft. is deep enough. Especial experience is required in levelling these ditches and too much care cannot be taken in this direction. In sandy soil it is sometimes found well to lay the tile on a 1-in. board, placed on the bottom of the ditch, and then place about 1 ft. of clay on top of the tile before filling in the ditch with the ordinary material.

## THE JOHNSON GARBAGE CREMATORY.

We illustrate herewith a crematory for burning garbage which has recently been tested in Chicago, it is stated with very satisfactory results. This furnace is the invention of Mr. William Johnson, 102 East Madison St., Chicago, Ill., and is being promoted by the American Refuse Crematory Co., A. A. Goodrich, President, 863 The Rookery, Chicago.

Briefly described this furnace is 38½ ft. in length, by 10½ ft. wide, by 33½ ft. high, outside measurement. The walls are of common brick, 17 ins. thick, lined with 9 ins. of best fire brick, making the furnace chamber proper 6 ft. wide by 34 feet long. Extending from near the top of the furnace chamber at the side wall near the bottom and spanning the width of the furnace, are two oppositely inclined grates, lying at an angle of 58° and resting upon a series of fire brick arches.

The garbage is deposited in hoppers at the exterior of the furnace upon the upper end of the grates and feeds by gravity along the grates, the end of which terminate 5 ft. from each other and just above a horizontal grate designed to receive that portion of the garbage that is not burned satisfactorily in its passage down the inclined grate. The ashes that result from burning the garbage fall through the inclined grates upon slides below which run parallel with the grate and terminate at the ash pit into which all the ashes are discharged.

Immediately above the horizontal grate is a vent 2 ft. in diameter, and near the top of the furnace is another vent 3 ft. in diameter, both leading to the smoke stack, which is 8 ft. from the furnace, 125 ft. high, and lined with fire brick throughout, as are the vents or connections with the furnace. The inside diameter of this stack is 3½ ft. At each end of the furnace and below the upper grates are tuyeres or blast pipes through which burning blasts are forced to the interior of the furnace. These tuyeres are placed at the center of the furnace so as to direct the flame toward the under side of the grate below the point where the garbage is fed into the furnace, thus producing an agitative blast, which disintegrates and spreads the mass of garbage fed into the hopper. Above and below the grates on each side of the furnace are other tuyeres or blast pipes projected through the side walls of the furnace. All of these tuyeres point toward the center of the furnace and produce propulsion blasts which serve to disintegrate and keep the garbage in motion. They are all funnel-shaped and flare inwardly to afford opportunity for the spreading of the flame jet.

In a letter describing the operation of the furnace Mr. Johnson says:

When the garbage is delivered to the furnace through the hoppers, it falls upon the sharply sloping grates, is instantly struck by the agitative blast, and any lumps or solid matter are broken up. On their farther passage down the grate they are subjected to cross blasts from the side tuyeres, which serve to keep up a continual commotion inside the furnace, where the finely divided particles are subjected to a constant temperature of 3,500° F. The passage of the garbage through the furnace is exceedingly rapid, and it has been found by practical demonstration that from 10 to 15 tons of garbage per hour have been consumed by this furnace without

smoke or odor, and leaving a residue of less than 10%, which can be easily taken care of by one man.

In a furnace constructed as this is, if the quantity of garbage to be burned is small or limited in supply, only one end may be used with perfectly satisfactory results. After the temperature of the furnace is once raised to the desired degree, it can be maintained at that degree by the use of only four tuyeres, notwithstanding the constant discharge into the furnace of fresh garbage.

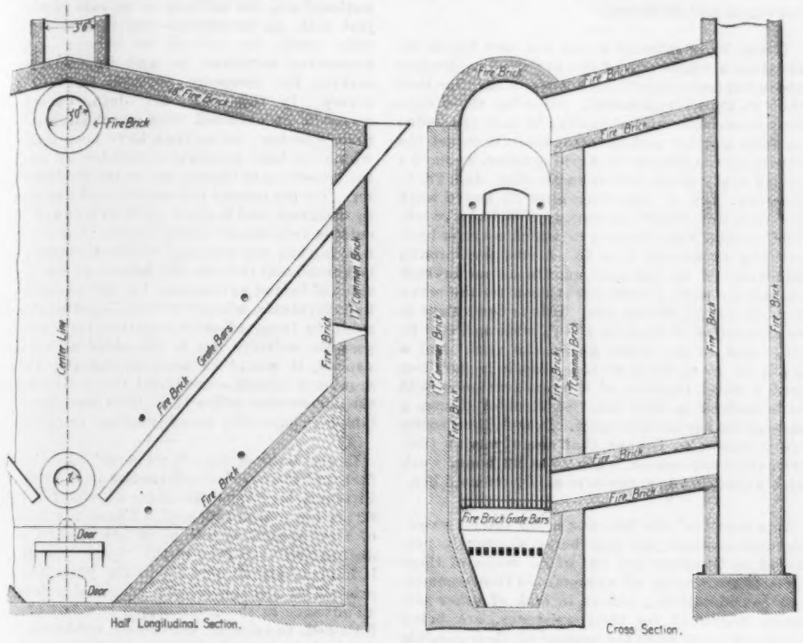
The arrangement of blasts through the tuyeres is such that the garbage is constantly kept in motion along the grates and the blasts are so strong, 100 lbs. per sq. in., that the garbage becomes instantly finely divided, in which condition it is thoroughly burned. No noxious gases are given off by the furnace, in which combustion is as near perfect as possible, said gases as well as all organic matter or animal life being consumed in the furnace.

As every portion of the inside of the furnace, grates, arches and walls has been built of the best fire brick, and as after severe and repeated tests there is no evidence of disintegration, the furnace should, and undoubtedly can, be run steadily for a very long period without repairing or relining.

In a test recently made, the furnace burned 72 tons of mixed refuse (garbage and other refuse) in four hours at a cost for fuel and attendance of $20.35 or 28.2 cts. per ton, according to a statement of the inventor. This cost included the fuel and labor necessary to heat the furnace thoroughly, before actual cremation began, which of course made the cost per ton somewhat greater than it would be when the furnace was in continual operation. As far as can be learned, no offensive odors came from the furnace or stack, and the only smoke was when a large mass of paper entered the furnace. The rapid combustion of this paper near the top of the grate caused a small puff of smoke from the stack. The refuse burned was mixed garbage, ashes and sweepings, and contained old cans, broken crockery, dead small animals, etc., no attempt being made to sort the material, which was taken just as the city's garbage wagons delivered it. The refuse was delivered to the hopper by means of a bucket conveyor, into which it was shoveled by men at the bottom. As the furnace was experimental this arrangement was somewhat crude and the intention is to improve it in the furnaces built for actual use. In other furnaces some changes in construction will also be introduced to simplify various small details.

We are indebted to the American Refuse Crematory Co., for the matter from which our illustrations have been prepared. The idea of this company is to dispose of the right to build and use the furnace or to contract with cities for garbage disposal.

Since writing the above the attempt of the company to get the city of Chicago interested in the device has failed partly through mismanagement and the company does not at present seem disposed to do anything further with it.

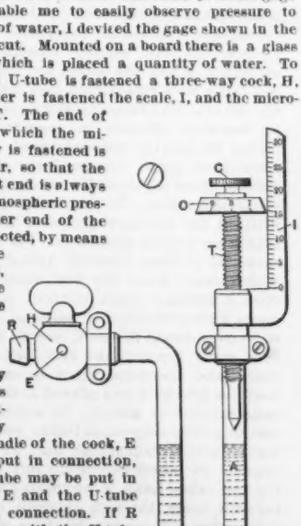



**EXPERIMENTAL GARBAGE CREMATORY AT CHICAGO, ILL.**
**Built by the Johnson Garbage Crematory Co.**

## A DRAFT AND BLAST PRESSURE GAGE.*

By J. H. Kinealy.

Having long wanted a draft and blast pressure gage that would enable me to easily observe pressure to within 0.01 in. of water, I devised the gage shown in the accompanying cut. Mounted on a board there is a glass U-tube, A, in which is placed a quantity of water. To one leg of the U-tube is fastened a three-way cock, H, and to the other is fastened the scale, I, and the micrometer screw, T. The end of the U-tube to which the micrometer screw is fastened is open to the air, so that the pressure in that end is always equal to the atmospheric pressure. The other end of the U-tube is connected, by means of a rubber tube fitting over R, to the place whose pressure it is desired to measure; E is an opening in the three-way cock, H, that is open to the atmosphere. By turning the handle of the cock, E and R may be put in connection, R and the U-tube may be put in connection, or E and the U-tube may be put in connection. If R is in connection with the U-tube and E cut out, the water in the left leg of the U-tube will rise or fall according as the pressure to be measured is less or greater than the atmospheric pressure, and the water in the right leg of the U-tube will fall or rise. Both legs of the tube are of the same diameter, so that the rise or fall will be the same in each, and the difference between the levels of the liquid in the legs will be equal to twice the rise or fall in one leg.




The scale is graduated to tenths of an inch, the micrometer screw, T, has ten threads to an inch, and the head, O, is divided into ten equal parts, so that the graduations on the head, O, represent hundredths of an inch.

The instrument is fastened to a wall or other place of support, so that the legs of the U-tube are vertical; R is connected to the place whose pressure it is desired to measure, and the three-way cock turned so as to connect E with the U-tube and cut out R. The screw, T, is then turned by means of the milled head, C, until the point on its end just touches the surface of the water in the U-tube, and the reading of the scale, I, and head, O, are taken. Next the three-way cock is turned so that the U-tube is in connection with R, and E is cut out, and the screw, T, is run down or up, as the case may be, until the point is again just in contact with the surface of the liquid. The readings of the scale, I, and head, O, are again taken. The difference between the first and last readings gives the rise or fall of the water in the right leg of the U tube, and this multiplied by two will give the pressure of the blast or draft in inches of water.

I have found by experiments that there is no trouble in determining when the point of the screw, T, touches the surface of the water, and in reading the scale and micrometer head to .003 in., although I seldom take a reading closer than .005 in. The end of the screw must be kept lightly oiled, so that a drop of water will not gather on it.

A glass tube whose internal diameter is ⅜ in. is not large enough to prevent the interference of the capillary attraction. If one of the legs is dirtier than the other there is a marked difference in the capillary attraction, and to get absolutely correct results, I find that the tube should be about ¾ in. internal diameter.

If the gage is to be used only to measure the pressure of blasts of fans the scale could be graduated to tenths of an ounce and the micrometer head to hundredths of an ounce.

* Abstract of a paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, in New York, Jan. 22.

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The state railways of Massachusetts have now 1,155 miles of track, and for the year ending Sept. 30, 1895, the total income was $13,246,371, and the total expenditure was $12,595,212. According to the report of the Railroad Commission of Massachusetts, the growth of business on these lines was almost phenomenal. There were carried the previous 3 years, in round numbers, 220,500,000 passengers; last year, 260,000,000, a larger increase than in any two preceding years combined. Of the 39,500,000 additional passengers carried, nearly 29,000,000 were carried on the railways of the eight largest established companies. Over 18,200,000 additional passengers were carried on the lines of the West End Ry., of Boston. This company carried the last year 155,231,506 passengers, or nearly 60% of the whole number carried on all the street railways of the state. The whole number of persons injured in connection with street railway operation was 1,507, of whom 25 received fatal injuries.

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Some new locomotives of the eight-wheel type built by the Great Western Ry., of England for passenger service on the Devon and Cornwall divisions, where the grades and curves are very severe, present some interesting features in construction. As noted in an article in our issue of Aug. 8, 1895, this road has been steadily opposed to the use of the truck or "bogie" on engines until within the last few years, but this new engine has not only a truck but an extension smokebox 5 ft. long. The truck wheels are similar to those used on the passenger car trucks, having teak wood centers. The smokestack is about 16 ins. inside diameter, but has a central pipe 12 ins. diameter, extending from the top down into the smokebox and having a petticoat piece 5 ins. deep about 9 ins. above the exhaust nozzle. The firebox has a firebrick arch at the tube plate end and a deflecting plate inside the firehole. The engines show a coal consumption of 30.4 to 31.6 lbs. per mile, and have attained speeds of 45.7 and 47.6 miles per hour with loads of 115 and 108 gross tons behind the tender. The general dimensions are as follows:

| | |
|---|---|
| Driving wheels, diam. | 5 ft. 7½ ins. |
| Truck wheels, diam. | 3 ft. 7½ ins. |
| Wheel base.—Driving | 8 ft. 6 ins. |
| Truck | 6 ft. 6 ins. |
| Total engine | 22 ft. 3 ins. |
| Length over engine and tender | 51 ft. 7½ ins. |
| Weight in working order, engine and tender | 156,800 lbs. |
| Cylinders (inside; inclined 1 in 10) | 18x26 ins. |
| Piston rod, diam. | 3¼ ins. |
| Boiler—Type | Straight top |
| Diam. of barrel inside | 4 ft. 3¼ ins. |
| Thickness of barrel plates | 7-16 in. |
| Thickness of smokebox tube plate | ⅝ in. |
| Height from rail to center line | 7 ft. 1¾ ins. |
| Length of smokebox | 5 ft. 0.⅞ ins. |
| Working steam pressure | 160 lbs. |
| Firebox.—Type | Crown-bar stayed |
| Length inside | 5 ft. 2 1-16 ins. |
| Width inside | 3 ft. 4½ ins. |
| Depth | 5 ft. 7 ins. |
| Thickness of tube sheet | ⅜ in. |
| Grate area | 19.11 sq. ft. |
| Tubes.—Number | 249 |
| Diam., outside | 1¾ ins. |
| Length between tube plates | 11 ft. 3¼ ins. |
| Heating surface. | |
| Tubes, exterior | 1,285.58 sq. ft. |
| Firebox | 115.27 sq. ft. |
| Total, with exterior tube area | 1,400.85 sq. ft. |
| Exhaust nozzle, diam. | 5 ins. |
| Smokestack, smallest diam. (inner pipe) | 12 ins. |
| Height from rail top | 12 ft. 10½ ins. |

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AND
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The American line steamer "St. Paul," which went ashore on the sand beach off Long Branch, N. J., in a fog, at 1.47 p. m., on Jan. 25, as noted in our issue of Jan. 30, was finally got off at 10 a. m. Feb. 4, after having been stranded nearly 10 days. During this entire time the vesselwas in danger of becoming a total loss in case a severe storm had arisen, yet those engaged in her rescue took no measures to get her off other than to remove her cargo and haul away at her with wrecking tugs; and her final safe removal must be ascribed to the remarkable good fortune by which the vessel was not exposed to heavy seas during the entire time she lay on the sands, but was finally favored with a sea just heavy enough to rock her loose, but not so severe as to cast her further ashore or do her injury.

To an engineer it seems strange that those in charge of the rescue of the vessel did not at once set to work to dredge her free when the first attempts to haul her off with tugs proved ineffectual. At high tide the vessel only needed 6 ft., more or less, greater depth of water to float free, and it is evident that a moderate amount of dredging along each side of the vessel, and from her stern seaward to deep water, would have been sufficient to set her free. Of course ordinary dredges are comparatively slow, and are not well adapted for doing efficient work in rough water, but the large sea-going, hydraulic suction dredges built for deepening the steamer channels in New York bay and across the bar (Eng. News, June 13, 1895), are just the sort of dredges requifed, being rapid in action, of enormous capacity, and being built specially for work in a seaway. These vessels have proved thoroughly satisfactory, and were purchased by the government after the success of their performance had been proved. Dredges of this kind have been used at a number of points on the coast, and large ones for use at Galveston, Tex., and at the mouth of the Columbia River, Oregon, were described in our issues of Nov. 7 and Dec. 12, 1895.

It is true, of course, that in the shifting sands in which the vessel lay the sides of the dredged channel would take a very flat slope; but this simply means that more material would have to be excavated. On the other hand, this very fact shows that, with a channel dredged on each side of her, the sand beneath the hull would have rapidly washed away and the vessel would have gradually settled down and floated. The fact that the magnificent vessel is finally set free is one in which every one will rejoice, for it would have been a thousand pities if one of the finest vessels of the American merchant marine had met so early and ignominious an end as threatened her while she lay aground. But her final escape by no means proves that the means employed to rescue her were not inadequat and inefficient.

It may be of interest to see just how big an excavation a single one of the big suction dredges above referred to could have made in the time that the "St. Paul" lay aground. Allowing three days for a reasonable trial of hauling by tugs and kedge anchors and for making arrangements to get the dredge on the ground in working order, we have a period of say seven days from Tuesday, Jan. 28, to Tuesday, Feb. 4. Allowing only 15 hours' work per day, this would amount to 105 hours' work. The big New York dredges to which we refer have actually excavated 8 to 16 cu. yds. per minute. Allowing 12 cu. yds. per minute as an average output, we have a total excavation for the seven days of over 75,000 cu. yds. This is equivalent to an excavation 15 ft. deep, 150 ft. wide and 900 ft. long, and as the water about the vessel had a depth of 15 to 20 ft. at high tide, it is manifest that a small fraction of this excavation would have sufficed to float the "St. Paul" and open a passage for her to deep water. In fact, there seems every reason to believe that there was no time after she went ashore when 24 to 36 hours' work with a dredge would not have safely released her.

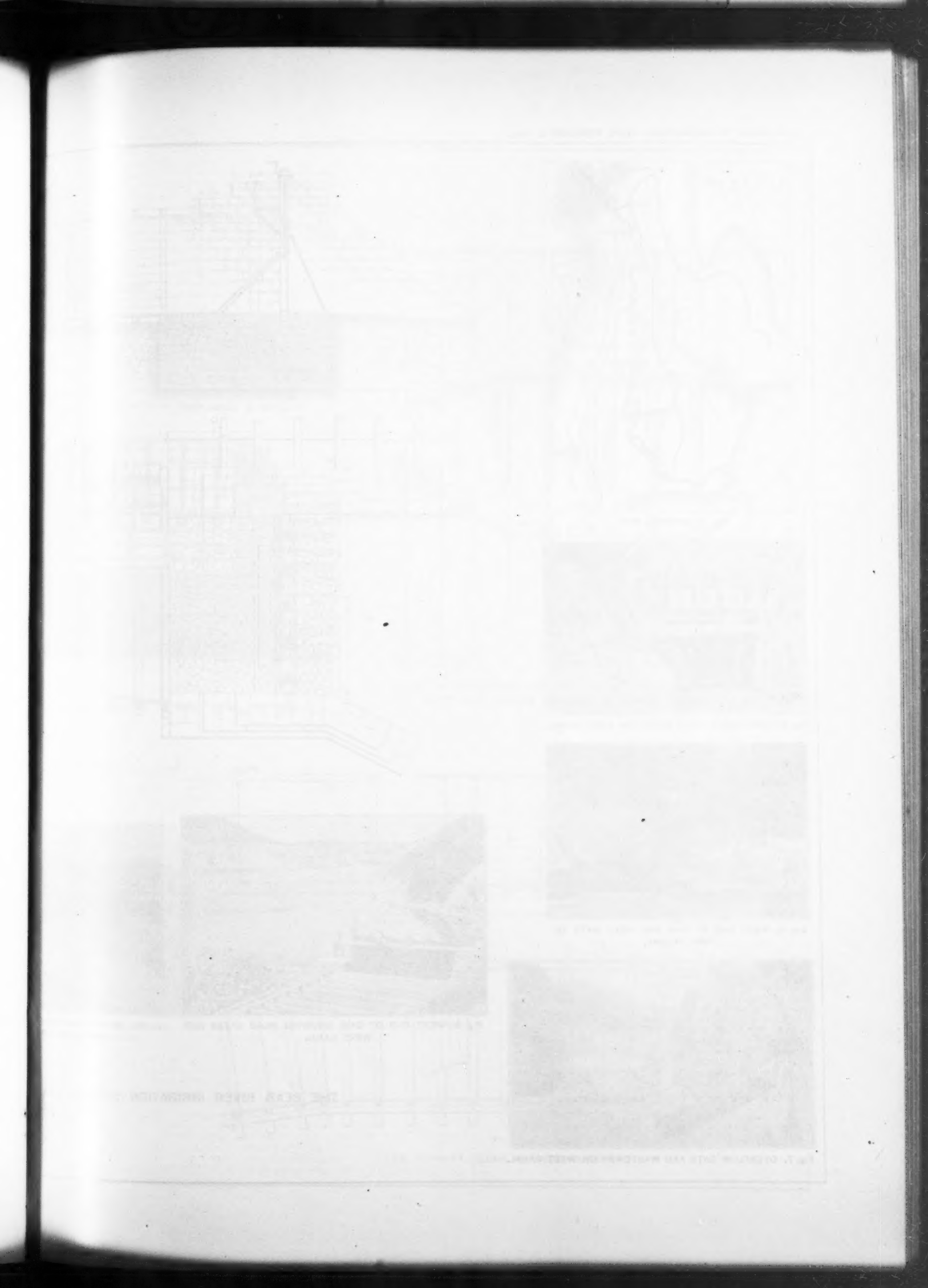
As a result of the late war scare inland waterway schemes are just now being vigorously promoted, in Congress and out of it. Some of these projects are worthy of national aid from commercial considerations; others, in lack of other sufficient argument for their existence, are being advanced solely upon the ground of their possible usefulness, in time of war, as inland routes for gunboats, torpedo boats, rams, etc., and this latter remark particularly applies to those that by the great depth of channels proposed come under the head of ship-canals. When the natural conditions, engineering features and traffic to be developed demand improvement of this character waterway transport is to be favored; and under these actual conditions individual enterprise and the federal government will usually combine in their construction when the times are favorable. But it is a fairly well-established fact that great depth in the several long inland waterways proposed is not an essential element in commercial usefulness, owing to greatly reduced speed, danger to structures from large ships and the entirely different class of ships required for ocean and for lake and canal navigation. If this increased depth is to be utilized for military purposes alone, there are strong arguments against it. For example, a ship-canal, 21 ft. deep, from the Atlantic to the Lakes, which would have the best reason for existence from a military point of view, would cost, at a guess, $200,000,000. If national defence is alone to be considered, it would be well first to estimate how many heavy guns and how many strongly built lake steamers, fitted to carry these guns, could be provided and placed at lake ports for the same amount of money. In a similar manner the cost of a deep ship-canal inside our Atlantic coast would arm fortifications and build battle-ships capable of better defending our chief sea ports. On the other hand, a provision for the passage of torpedo boats through existing canals, and the connection of these canals along the whole length of our Atlantic coast, has much in its favor; for such use would demand increased width rather than depth in the canal locks, and commerce would be benefited and excessive cost avoided.

The trouble with many of these ship-canal projects is that their promoters have not sufficiently studied the problems of ultimate cost and comparative commercial demands and use; or, which is the same in effect, they base these studies upon one-sided and imperfect data. Take for example the proposed 19 ft. canal to connect Lakes Michigan and Erie, for the construction of which its promoters now ask the government to assist to the extent of $30,000,000 or more. They talk glibly of a saving of 500 miles in distance, its use in national defence, which would imply its extension to the Atlantic coast, and a reduction in freight rates that would be equivalent to one-fourth of those now charged by railways. It is also promised that this canal would pay its operating expenses and cost of construction within ten years. If they could prove the latter assertions, relating to rates and traffic, there would be no need of national aid, for millions in private hands await just such an investment—provided that individuals could be induced to believe arguments considered sufficient to lead Congressmen into making the necessary appropriations of public money. In this case, all data, except such as could be obtained from a school atlas, seem to be wanting; no surveys have been made upon which to base accurate estimates of cost, and the guesses as to income are of the wildest character. Yet the scheme is deemed worthy of attention by Congress, and is given forth as being of "incalculable value to the United States;" and so far as figuring out any material benefit is concerned this last statement is true. We believe in the development of inland navigation, by the government or by individuals, whenever there is reasonable argument in favor of their construction; but when possible military use is the chief argument advanced, it would be more appropriate that this argument should come from the military arm of the government rather than from untrained civilians who have very possibly an axe to grind.

In our issue of Jan. 9 we noted editorially the fact that the coke manufacturers in the vicinity of Pittsburg had fixed the price of coke for 1896 at $2 per ton to iron furnaces, while at the beginning of 1895 it sold as low as 90 cts., and at no time during that year, even in the "boom" months, was it higher than $1.60. Up to the present time the price of $2 has apparently been maintained, and an advance in the price of pig iron has of course followed, in spite of continued weakness in the finished iron market. The producers and consumers of pig iron have now to reckon not only with prices of coke advanced far beyond a normal level, but with prices of Lake Superior ore, which will be no doubt very much higher than last year, on account of the formation of a "pool" which has made an "allotment" of the amount of ore to be shipped from the several districts of the Lake Superior region. Bessemer pig iron at Pittsburg is now quoted $13.00 to $13.25 per ton, as against $10.75 to $11 on Dec. 31, the advance being due entirely to advanced cost of coke and ore and not to any improvement in the demand for pig iron.

The manager of the Duluth Water Co., as is noted elsewhere in this issue, has been indicted for manslaughter on the ground that he had furnished impure water which caused the death of a man from typhoid fever. The city council of Duluth has experts at work in a search for typhoid germs, which has, thus far, been unsuccessful, in order to secure evidence to justify the council in annulling the franchise of the water company. This situation gives rise to some highly interesting questions. In the first place, how can it be proved by evidence which will stand in a criminal court that a specific death from typhoid fever was caused by water from a specific source? The death may take place weeks after the disease is contracted, thus, with other conditions, rendering it absolutely impossible to determine what the state of the water was when the patient was stricken. But this matters little, for the typhoid bacillus cannot be detected with any certainty, if at all, in natural waters, as the late investigations of the highest authorities show, notwithstanding numerous announcements to the contrary in former years and even now. Supposing, however, that it could be proved that the water in question had at some time contained typhoid germs, the infection might still be from some other source. The patient might have drunk from a polluted well within the city, or taken milk containing the germs, or received the infection while in some other city, or direct from some other person through carelessness of himself or others in caring for a typhoid patient.

Assuming that proof of specific deaths could be obtained, damage suits as well as convictions for manslaughter might be expected. Such procedures once started, it might follow that suits would be instituted for expenses caused by sickness in cases where death did not result.



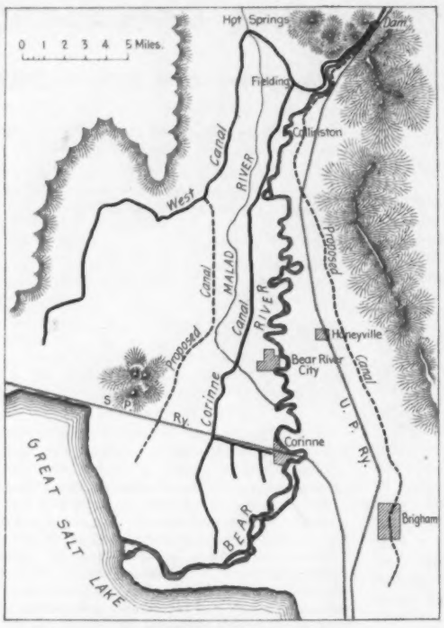
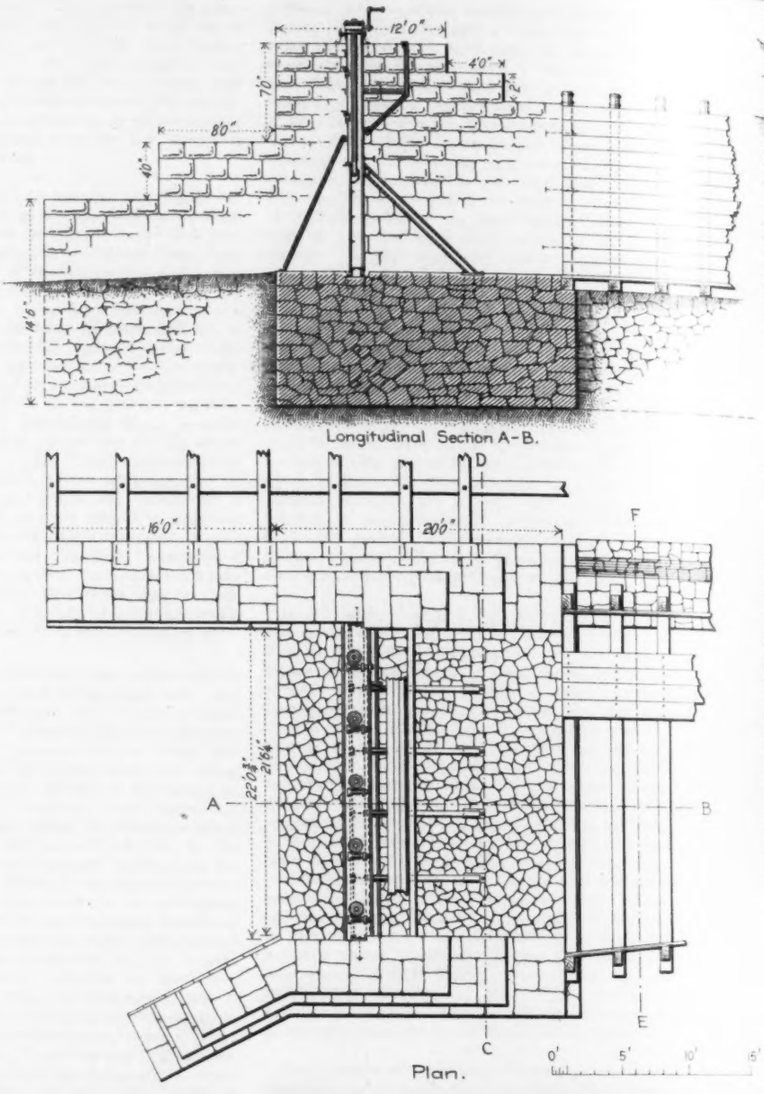



Fig. 1.—GENERAL MAP.



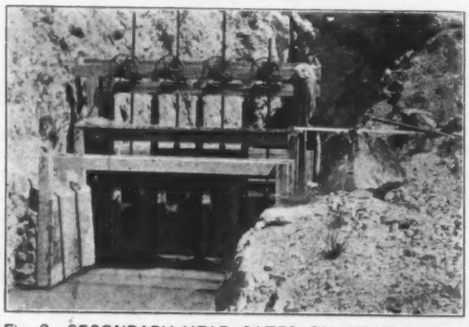



Fig. 8.—SECONDARY HEAD GATES ON WEST CANAL.

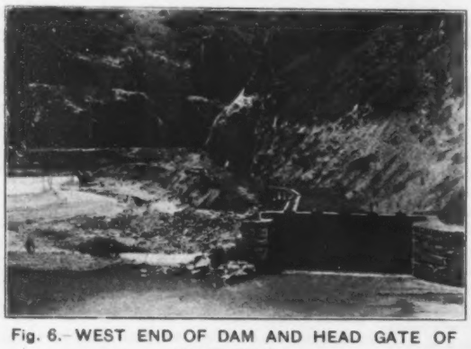


Fig. 6.—WEST END OF DAM AND HEAD GATE OF FIRST FLUME.

Fig. 7.—OVERFLOW GATE AND WASTEWAY ON WEST CANAL.

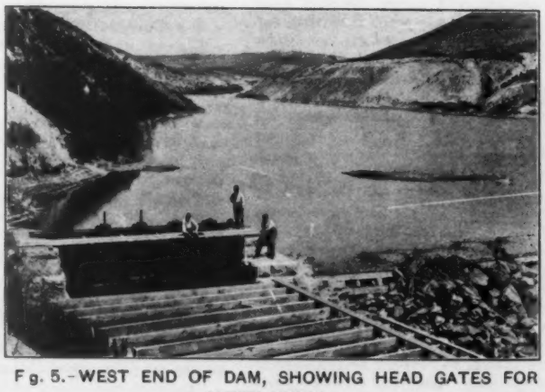


Fig. 5.—WEST END OF DAM, SHOWING HEAD GATES FOR WEST CANAL

Fig. 11.—DOUBLE HEAD
BRANCHING OFF

THE BEAR RIVER IRRIGATION SYSTEM, UTA

GENERAL LIBRARY
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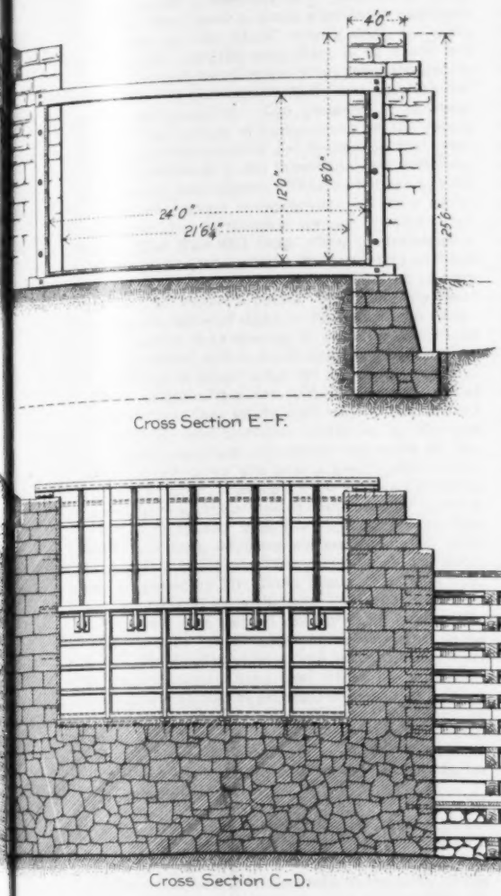



Fig. 4.—HEAD-WORKS OF WEST CANAL, AT DAM.

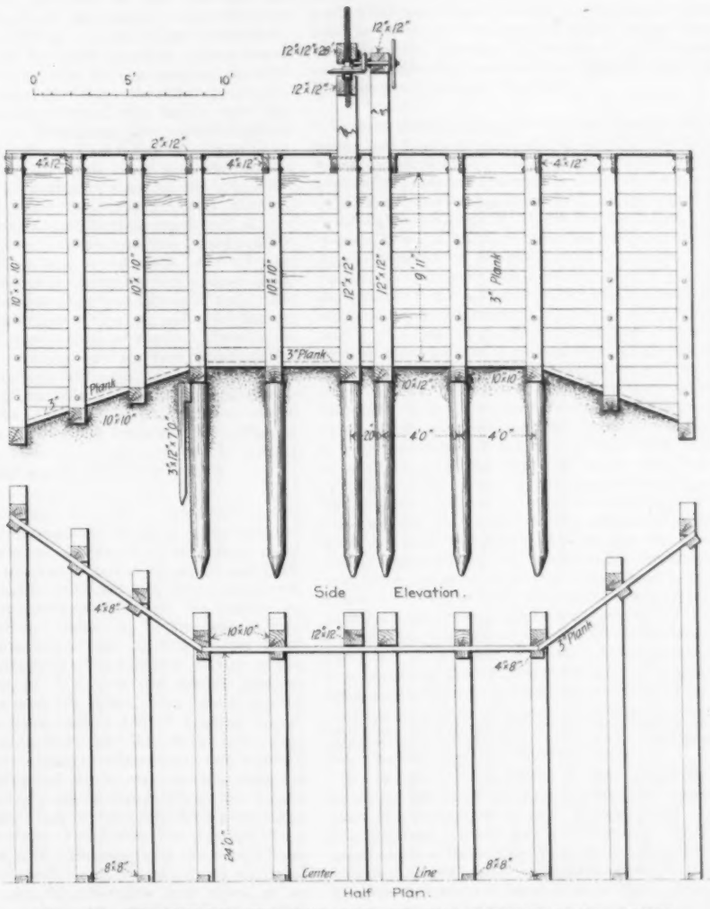
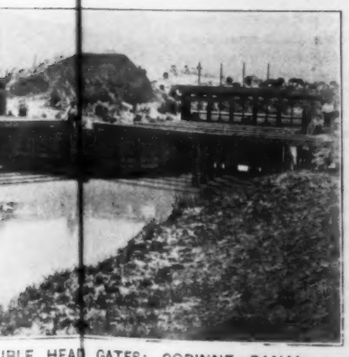



Fig. 12.—STRUCTURE FOR ONE SET OF THE DOUBLE HEAD GATES WEST AND CORINNE CANALS; J. C. ULRICH, Designing Engineer.



UBLE HEAD GATES; CORINNE CANAL
NCHING OFF FROM WEST CANAL.

EM, UTAH.

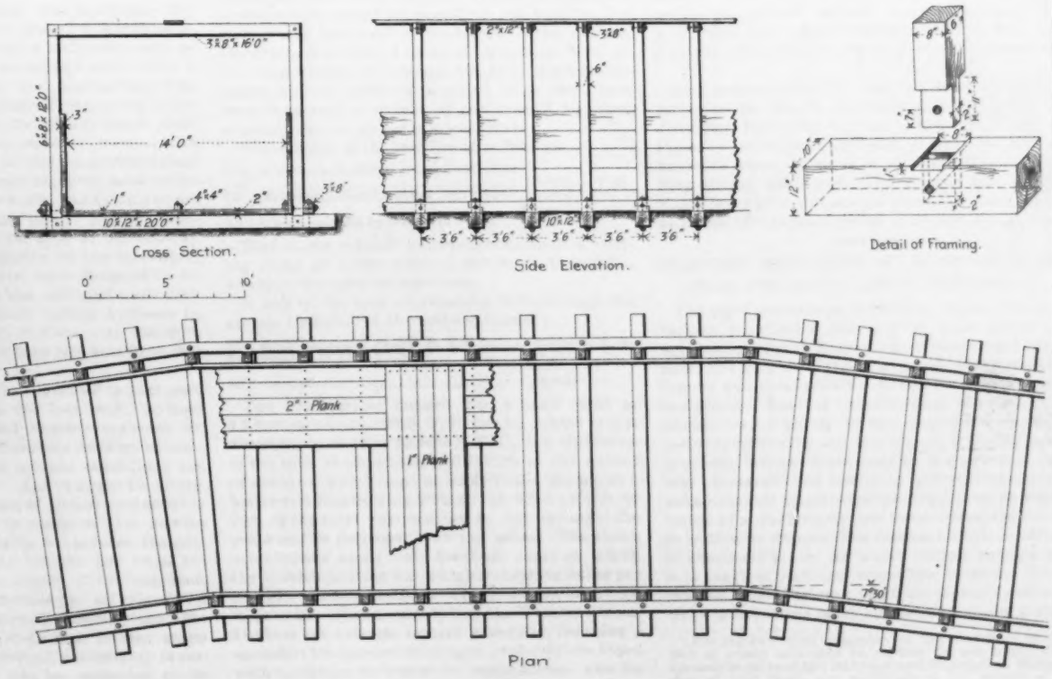
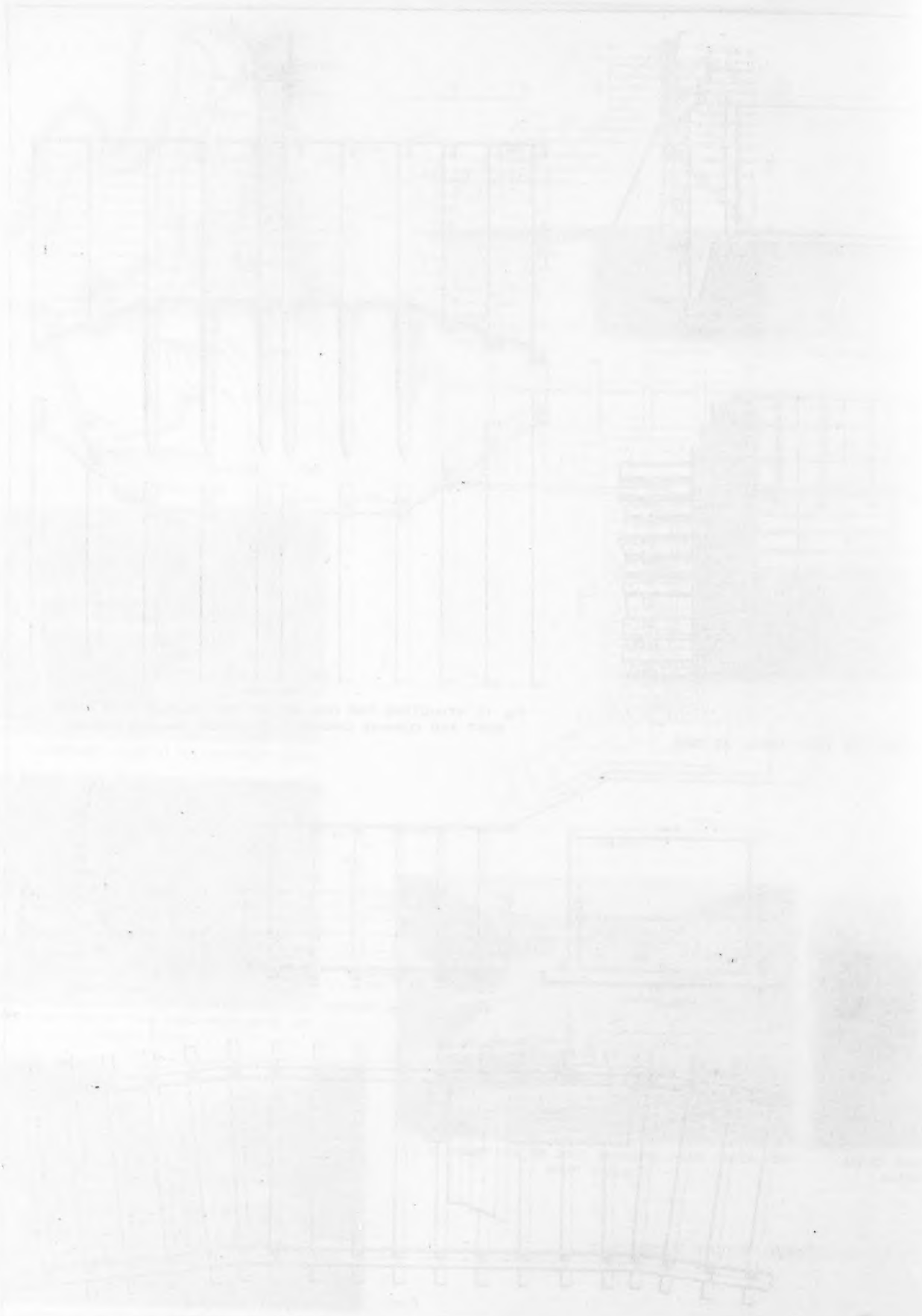



Fig. 10.—98-FT. FLUME IN WEST CANYON.



While as yet it does not seem possible to bring sufficient legal proof in these matters to warrant a conviction, or very likely even a trial, for manslaughter in a specific case, there is no doubt but that scores and hundreds of lives are sacrificed in city after city throughout this land through impure water supplies. The progress of sanitary science, the further enlightenment of the people and the crystalization of public opinion will eventually be reflected in our laws and court decisions, so that some punishment will be meted out to both public and private corporations, or their representatives, for furnishing sewage contaminated water. The time will come when bacteriological proof that a water contains disease germs will not be deemed an essential step in excluding sewage from public water supplies. The mere physical proof of the sense of sight, or the knowledge, however obtained, that sewage is actually going into drinking water, will in those eagerly awaited days be sufficient to secure steps for an instant remedy.

Many communities are to-day in such a wofnl condition that they might well employ men versed in morbidity and mortality statistics on the one hand, and in sanitary preventive measures on the other, to set down and cast a yearly balance between the value of human lives lost and sickness caused, with all the attendant expenses, by typhoid fever, as compared with the expense of securing water and milk supplies not contaminated with dangerous impurities. This general plan was actually suggested by Mr. Allen Hazen, not long ago, before a body of scientific men. While it of necessity ignores that part of the value of human life which cannot be measured by money, this is no reason for condemning it, but rather in its favor, with the understanding that where the computation shows the cost of preventive measures tipping the balance, the higher feelings of man may be brought to bear in all their weight, and human lives be preserved and hearts remain unbroken, with utter disregard to cost so far as the latter may be possible.

The report of the board of experts upon the defects of the Harlem River Speedway contains a lesson for over-hasty city commissions in charge of similar work, and it is especially interesting to the taxpayers who must foot the bill for repairs. In this case the responsibility for the damage done must rest upon the shoulders of the late Board of Commissioners of the Department of Public Parks. The President of that body openly professed a contempt for engineering service as an essential preliminary to a piece of work that was to cost a large sum of money and was located in a place where careful and intelligent work was essential. No borings were made along the line of a heavy cribwork which was to be placed on soft mud; and, as is usual in such cases, the soundings made with a rod proved untrustworthy and misleading. The engineer in charge was hampered by clauses in the contract limiting the total cost of any single piece of work; and these clauses probably induced him to omit the enforcement of provisions in the original specifications which later events proved to be necessary for the stability of the work. As a result of the omission of brace-piles and timber grillage, combined with careless filling, the arch of the subway is badly cracked by the bulging of the face-wall; and owing to imperfect data, cribs designed to be 18 or 20 ft. deep sunk into the soft mud until they were 48 ft. deep. Extra work caused by haste in executing the first contract cost the city $39,600, and the repairs to the work done may cost $150,000 more.

The moral of this lesson is contained in that part of the report setting forth the fact that "no time is saved in completing any engineering work by hastening the work of preparation unduly, or commencing the work before all the conditions are known and provided for." And it might be added that, as in this case, a waste of money and effort is very likely to follow as a result of this unwise haste. The report practically exonerates the contractor from responsibility for the bad work because he acted under the orders of the engineer. But it is also very evident from the actions of the Park Board toward engineers generally that the engineer in charge of this work was neither given the time necessary for sufficient preliminary investigation and plans, nor was he supported as he should have been by the terms of the contract and by the Board itself. That he lacked in judgment in permitting the contractor to omit specified but troublesome details of the work seems evident in the case of the subway; but, as before mentioned, he was hampered by fixed quantity—prices based upon imperfect data, and he was tempted to save in work to compensate for over-running quantities. The blame for all must rest finally upon the President and the Board, and the narrow-minded prejudice and ignorance that failed to recognize in this speedway any demand other than the opportunity to give a contractor work at the city's expense. Every other consideration was thrown aside and the result is set forth in the report of the experts. The late President of this Board fought vigorously against the employment of civil and landscape engineers in designing and constructing a work that demanded the best efforts of both. He regarded their services as useless and their fees as an unnecessary expenditure of funds. It would be an interesting problem now for this President to figure out how much his peculiarly economic administration of the city's affairs in connection with this speedway has cost the city. And it would be equally interesting for taxpayers to estimate what it costs, here and elsewhere, to put incompetent men upon commissions of this kind.

Our correspondent, W. R. W., in his letter on the "Relative Advantages of Hand and Mechanical Stoking," published elsewhere in this issue, calls attention to a method by which an apparently high evaporation may be obtained in a steam boiler test by "expert manipulation," which, we believe, is commonly called "jockeying." The means employed is the burning of the volatile matter from the coal and allowing a considerable portion of the resulting coke to fall into the ash-pit and be weighed along with the ashes. The volatile matter is supposed to have a much higher heating value, for equal weights, than the coke. It is quite possible that this "expert manipulation" may explain some high boiler test results, expressed as evaporation per pound of combustible, in which the record shows that ashes and refuse were a high percentage of the total weight of coal used, but it is not likely that the error thus introduced can often be a large one. We have made a calculation, given below, of an assumed case, to determine how much of an error can be introduced into the record in this manner. Suppose a boiler test made with a first-class semi-bituminous coal, the combustible portion of which consists of 80% fixed carbon, 20% volatile hydro-carbons, and its heating value as determined by an oxygen calorimeter is 15,800 British thermal units per pound. How much may the result of a boiler test made with this coal, expressed in pounds of water evaporated per pound of combustible, be erroneously increased by so handling the coal on the grates that 25% of its fixed carbon, or 20% of the total weight of combustible, falls through the grates and is deducted together with the ashes from the record of weight of coal burned, in order to obtain the weight of combustible?

The solution of the problem is as follows:

| | |
|---|---|
| 1 lb. of the combustible has a heat value of ..... | 15,800 B. T. U. |
| Of which 0.8 lb. carbon gives .8x14,500.. | 11,600 " |
| And 0.2 lb. volatile hydro-carbon gives... | 4,200 " |

That is, the volatile hydro-carbons have a heating value of 4,200÷0.2=21,000 B. T. U. per lb., or about the same as petroleum.

If 20% of the total combustible falls through the grates, we have for the amount burned:

| | |
|---|---|
| 60% fixed carbon @ 14,500 B. T. U..... | 8,700 B. T. U. |
| 20% volatile H. C. @ 21,000 " ..... | 4,200 " |
| 80% burned..... = | 12,900 " |

The combustible burned has a heat value of 12,900÷0.80=16,125 B. T. U. per lb., which is just about 2% more than 15,800 B. T. U., the full value of the total combustible, and the 2% is the extent of the error which may be made in the record of a boiler test by allowing 25% of the fixed carbon, or 20% of the total combustible to fall through the grate and be reckoned with the ashes. The above calculations apply only to those coals in which the volatile portion has a higher heating value per lb. than the fixed carbon. This is not the case with most of the bituminous coals of the Western States. In these the volatile matter generally contains a considerable amount of oxygen, probably combined with hydrogen as water of combination, and its fuel value may be much less than that of carbon. With such coal a removal of the fixed carbon through the grates would be a removal of the portion of the coal which has the highest fuel value, and the result of a boiler test made under these circumstances, expressed in pounds of water evaporated per pound of combustible, would be less than the true result instead of greater.

Several recent changes in city offices point anew to the fact that appointments of municipal officers having to deal with work involving more or less engineering, are too often made on the basis of personal or political obligations, and not upon that of technical knowledge or fitness for the office. At Boston, Mass., a business man has been appointed Superintendent of Streets by the new mayor, replacing an engineer. This means that if the department is to be operated with proper regard for efficiency and careful expenditure of the people's money, the head of the department must rely very largely upon the executive engineer, which simply means that the head of the department will be an unnecessary intermediary, drawing a large salary, and liable to be influenced by political considerations rather than economical considerations and the best interests of the community. The mayor is credited with the idea that under the present system of organization engineering knowledge is not requisite, but that "business training, executive capacity, organizing ability and knowledge of men" are more essential qualifications, the mayor being apparently under the mistaken impression that these qualifications are not possessed by engineers. The department in Boston has control of nine divisions, employing in all about 2,500 laborers, and has the expenditure of about $3,500,000 per year. In another town the appointment of a new Superintendent of Streets was recently blandly commented upon by a local paper as follows:

> He has never had any experience in street building or repairing. He is young and intelligent enough to quickly learn the tricks of the trade and to avoid any mistakes that may have been made in former years.

We wonder if the editor of that paper would write in the same strain regarding the appointment of a real estate agent as health officer, or of a young doctor or clerk as city attorney? Such appointments as these would hardly be suggested, or accepted by the people, so palpable would be the objections, but when it comes to a position requiring the professional knowledge of an engineer to properly perform its duties, it seems to be very generally considered that anybody can fill the position and pick up the necessary knowledge while filling it. Possibly he can (though probably he will not) in some of the less responsible positions, but the city does not, or should not, pay salaries to educate men to do its work, especially as these appointments are almost always temporary, changing with each new administration, so that the city does not even get the advantage of such education.

By a printer's error in our last week's issue the formulas in Mr. E. Sherman Gould's letter on "Simpler Formulas for the Flow of Water in Pipes," were printed with plus signs in the second terms in place of signs of multiplication, which they should have had. The present flow of the East Jersey pipe line should also have been stated as 35,000,000 gallons instead of 34,000,000 gallons.

## STATUTORY REGULATION OF INTERLOCKING SIGNALS FOR RAILWAY GRADE CROSSINGS. *

The rigid supervision of railway signals by regulations practically statutory in their power has been recognized in England as desirable and necessary, and such supervision, as nearly every engineer knows, has been strictly enforced for some years by the Board of Trade of Great Britain. In the United States, owing partly to the comparatively small use of interlocking and block signals, partly to the generally less attention paid to the safety of railway operation, and partly to different social and governmental conditions, no regulation or supervision of a similar sort has been attempted except in isolated instances. The reasons for this condition of affairs are hinted at above clearly enough, and it is needless to enlarge upon them further. It is of interest, however, now that the signaling of railways is becoming more common, to study a little

* For the historical summary of the statutory regulation of grade crossings in Illinois we are indebted to various reports of the Railroad and Warehouse Commission of that State, and especially to the report of the present consulting engineer, Mr. Dwight C. Morgan, for the year 1895.

into the possible advantages of regulating the work by statute. To do this we shall trace briefly the success and the difficulties of the most serious attempt of this kind which has yet been made in the United States, viz., the statute regulating the interlocking of grade crossings in Illinois, and study into how far they teach anything as to the possible success of a national law.

In the State of Illinois, previous to the year 1872, there was no law tending to prevent collisions at grade crossings, but the element of danger from such crossings was recognized by the railways in the very general practice of stopping all trains before crossing the tracks of intersecting roads. The rights of respective companies to precedence, and a very great indefiniteness as to what constituted a crossing, were the most serious difficulties under this arrangement. Recognizing this, a law entitled, "An Act To Prevent Injury To Persons or Property at Railroad Junctions and Crossings," was passed in 1872. As will be noted, the date of this act was previous to the installation of the first interlocking plant in the United States, and consequently its requirements did not recognize such safety apparatus. Briefly stated, it required all trains to stop at least 200 ft, and no more than 1,000 ft. from crossings and junctions before entering upon them. Even with this law the understanding as to the relative crossing rights of trains was not done away with, and besides, the increasing traffic and development of safety devices soon made the law a back number, both in principle and in its practical working, for stopping the trains was the only legal protection afforded and the only protection which could be enforced, despite the fact that signaling appliances could be constructed which would render stopping wholly unnecessary.

Except an amendment making the law applicable to swing-bridges as well as crossings, which was enacted in 1885, no further legislation to secure safety at grade crossings was accomplished until 1887. At this time the absurdity of the conditions mentioned in the preceding paragraph, and also the necessity of a more advanced stand in safety regulations, was brought to the attention of the Legislature. The result was an "Act in Regard to the Dangers Incident to Railroads Crossing on the Same Level."

This law did not repeal the provisions of 1872, or the amendment of 1885, but simply provided further, that upon the construction of a signaling appliance at grade crossings of a character approved by the Railroad Commission as safe and efficient, it should be lawful to run over such crossings without stopping. In case the signaling appliance proved unsafe, the Railroad Commission also had power to discontinue its use. The law was not mandatory, so that the protection of a crossing was an entirely voluntary action on the part of the companies whose lines crossed. This, it will be seen, necessitated between the railways crossing each other an agreement as to the advisability of an interlocking plant, the proportioning of the cost of construction and maintenance, the type of signaling device to be used, etc., etc.; and if the railways did not agree, there was no power to decide between them or to compel a protective device, no matter what the necessity was from the standpoint of public safety. A stubborn or unprogressive railway thus often practically prevented any improvement, however willing or desirous the line crossing it might be for improvement.

For the reasons just mentioned, it seemed apparent to the Railroad Commission that further legislation was desirable, and in 1891 it was secured, largely through the efforts of Mr. Charles Hansel, M. Am. Soc. C. E., then Consulting Engineer of the Railroad and Warehouse Commission of Illinois. The new law did not affect the provisions of the statute of 1887, but conferred such additional power on the Railroad Commission as enabled it to determine disputed cases and compel protection. Previous to this statute an act had been passed in 1889 giving the commission jurisdiction over the location of all new crossings. It is in this condition that the Illinois statutes now stand in respect to the crossings of railways at grade, and their practical workings are as follows:

(1) The railway companies are given an opportunity to agree between themselves on the various points involved in the protection of any crossing on their lines.

(2) In case the railway companies cannot agree upon any or all the points, either company can appeal to the Railroad Commission for its determination of the point or points in contention.

(3) If any railway crossing is deemed unsafe by the Railroad Commission power is conferred upon the commission to compel the railways to show cause why the crossing of their lines should not be protected by an interlocking signal.

(4) The installation of a safety device once decided upon, the Railroad Commission has authority (1) in approval of the device used; (2) in examination after completion to determine whether all reasonable precautions have been taken to ensure its safe and efficient operation, and (3) in granting a certificate of authority to operate the device under the following provisions: (*a*) the provision of competent persons to operate, inspect and keep the device in thorough repair; (*b*) each train to be brought under such control after passing the distant signal as to enable it to be stopped within safe distance should danger appear between the distant signal and the crossing; (*c*) no change in location or alteration in construction and operation of the device to be made without the approval of the commission.

The questions which now arise are: What has been the success of these laws in bringing about the conditions desired, and what have been the difficulties of enforcing them? One question involves the other and both may be answered at the same time. Up to June 30, 1895, 115 interlocking plants, protecting 131 crossings, have been installed. Of these plants 99 have been constructed by agreement between the railway companies, 16 cases have been appealed to the commission, several of which were afterward agreed upon and dismissed at the request of the petitioners, and three citations have been issued by the commission, one of which was dismissed, one agreed upon, and one merged into a petition. The most significant fact, however, is that between June 30, 1887, and June 30, 1891, four years, only 25 crossings were equipped with interlocking signals, while in the four years from June 30, 1891, to June 30, 1895, 90 crossings were so equipped. These figures are worth a little study.

It is evident at once that in the majority of cases mutual arrangement between the companies interested was sufficient to effect the improvement without the aid of the commission; but on the other hand the great increase in the protection of crossings since 1891, leads one to believe that the fact that the commission was in existence, with power to enforce action, was influential in inducing action and mutual agreement on the part of the railway companies interested.

One of the difficult tasks which the commission has been called upon to perform, is the division of the expenses of interlocking plant between the two railway companies whose lines intersect. Many different methods have been proposed for effecting an equitable division. The principal may be enumerated as follows:

1. That the division should be effected in proportion to the number of tracks of each road.

2. That the division should correspond to the number of trains sent over the crossing daily by each road.

(3) That the division of expense should be in proportion to the number of levers in the interlocking machine required for each road.

(4) That each road should construct the device in its own tracks and allot the expense of operation according to the levers required for each road.

(5) By the force of existing contracts or agreements between the companies as to the protection of the crossing and the division of expense.

Consideration has been given to all of these contentions in the various decisions of the commission according as the conditions seemed to require. It seems to have been found impossible to lay down any unvarying principle of determination applicable under all conditions. This is just what might be expected.

A study of the foregoing outline, we think, can but convince one that altogether the statutory supervision of interlocking signals for grade crossings has been a success in the State of Illinois. Without doubt mistakes have been made in the past and improvements will be made in the future, but on the whole the law has proved its great value. This being the case the question at once arises: Why would not a similar law be of value for every State? One's first impulse is to answer that it would be of value, but a moment's consideration shows that the question is one which should not be answered off-hand.

Few will dispute at the present day that there is a legitimate field for the exercise of some authority over the railways in this matter of safety appliances, both in the interest of public safety and for the benefit of the railways themselves. How this authority should be exercised so as to be at once effective and duly cautious and conservative is a more difficult problem. The United States has committed itself to the plan of State commissions for regulating its railways, keeping free from Federal intervention, except where the interstate nature of the regulation places it in the hand of the general government. The Federal laws—so far as there are any—take up railway regulation at the point where the State laws become inefficient—that is, in the regulation of interstate commerce. There are faults in this system of regulation, it must be admitted, but at the same time the system is one to which the country has committed itself and which we must recognize in considering the best method of regulating any particular phase of railway operation.

The difficulty of proper regulation under the above system is the difficulty of drawing the line between the things which should be left to State control and to Federal control. The laws now in force regarding the installation of automatic couplers, grab-irons, etc., are Federal laws, and it certainly seems reasonable that any safety device attached to cars and locomotives passing from one State to another, in which uniformity is desirable, should be controlled by Federal rather than State laws. On the other hand, the supervision of bridges, track and permanent way can be done without serious interference by each State for itself. The interlocked signal is a local structure like a bridge, but uniformity of certain features in the construction and operation of signals at different points on the same line are highly important in the interests of safety. To subject such signals to rules and regulations* made by half a dozen legislative bodies or State Commissioners would make possible some very serious variations from the uniformity that is so desirable. From this point of view regulation by the Federal Government seems unquestionably the system to be favored.

Although the regulation of interlocking signals in Illinois is State regulation, its successes and failures in attaining the object sought have been controlled by the same features that would control the success or failure of a law covering two score of States instead of one State, and for this reason it is worth study. The salient features of the Illinois law have already been given, and they may all be collected under two heads: (1) The execution of the law is placed in the hands of a special commission of experts; (2) the law is mandatory. Are both of these features desirable to a Federal law covering the whole country?

It will, we think, be admitted by intelligent men at the outset that the obstacles in the way of a beneficial interference of the Legislature direct with railway technical matters are very great. The absurdity of such interference will appear more clear if we take the concrete case of Congress assuming to decide itself the kind of interlocking machines to be used or any one of a dozen other things. Congress, however, may delegate its power to some competent body. It might create, say, a commission of railway safety appliances. In short, the laws must be executed through a commission, and this commission must be made up of men thoroughly honest and versed in every detail of the subject of railway safety appliances. While it does not appear in the official reports of the Illinois State Railroad & Warehouse Commission, the fact is none the less true that the success of the execution of the law relative to interlocking signals is in a very large measure due to the honesty and efficiency of the expert advice of the consulting engineer.

The commission once agreed upon, the question arises: What powers should the law delegate to it? The Illinois law is mandatory, but, as has been shown, this power of the commission has been sparingly used. The chief value of the power has been to establish a tribunal which could prevent obstinate and unprogressive railways from block-

* For a careful summary of State Laws regulating railways, made with the view of showing their lack of uniformity, see Eng. News, April 9, 1892.

ing improvement and which could decide disputes as to relative rights. It is here, we think, that the chief value of mandatory power is found. To allow a commission such power in specifying the kind and type of signaling devices to be used is not wise, because it opens the way to fraud and persecution, and we think is not necessary to the success of the result to be brought about. Experience in Illinois has shown that the mere recommendation of the commission, when manifestly wise, has as a rule been followed by the railways in the matter of the best devices to be used. The same experience has been had in other States. Few railway managers will dare to disregard the recommendations of an honest and expert commission for fear of public opinion. The mere fact of periodically bringing before the public, by reports, the progress made by different roads in the adoption of safety devices has in the past, and will in the future, prove a powerful incentive to further progress. In a future issue we shall discuss further the manner in which advisory powers may be wielded. There is, however, a certain moral effect in a mandatory law which is of value, and if it can be given to a commission, surrounded by such safeguards as will prevent abuse, it is a desirable thing. Such safeguards can be provided by making the mandatory power an action of last resort. One can conceive of a number of ways to accomplish this end, but it is unnecessary to go into that feature here.

The question may be asked: "If a mandatory law has proved a success in Illinois, why should it not prove a success elsewhere?" An endeavor has been made to show why in the preceding paragraphs, but it is so important a question that the answer may be repeated. The mandatory law in Illinois has proved a benefit instead of an injury simply because it has been executed with great discretion. The commission has contented itself in most cases with simply advising and suggesting, and the railways have been found willing to follow this advice. With a different administration, an altogether different result might have been shown. The power of compelling things to be done which involve a tremendous outlay of money is an unwise power to place in the hands of any public official, especially when it is to a large degree an unnecessary power.

To summarize briefly the statutory supervision of safety devices for railways is a legitimate power, and it can be exercised best by a Federal commission of experts. The power and duties of this commission should be advisory and educative, except possibly as a last resort in the case of especially flagrant offenses against the public welfare, when mandatory power may be given.

# LETTERS TO THE EDITOR.

## Superelevation on Curves.

Sir: Will you kindly inform us how the formula for elevation of outer rail is deduced and what factors enter into it?

Dudley Britt, Engineer,
Alexander & Red Mountain R. R.

Alexander, W. Va., Jan. 7, 1896.

(The principal factor in determining the superelevation is the speed of the train, and its consequent centrifugal force, this force being obtained by the following formula:

$$C = \frac{\text{Weight} \times \text{Square of Velocity}}{32.2 \times \text{Radius}}.$$

To counteract this lateral force the outer rail is raised a certain amount, which is arrived at by the following formula:

$$E = \frac{\text{Gage (or distance c. to c. of rails) in inches} \times \text{Square of Velocity}}{32.2 \times \text{Radius (feet)}}$$

This gives the theoretical elevation in inches, but practical considerations of traffic and location very generally require some modification to be made in each individual instance.—Ed.)

## Quantities of Paint Required for Bridges of Various Spans.

Sir: The writer encloses herewith a paint table which has been published by one of the paint firms. This table was gotten up by the writer as a check list for the use of our erectors. As far as known, very few bridge companies keep any record of the number of gallons of paint used on spans of different lengths. This table was made up after the appearance of the article by W. G. Berg, of the Lehigh Valley, in "Engineering News" of June 6, 1895 in which he stated the covering capacity of the different kinds of paint. After reading this, the writer addressed to all of the prominent paint firms a letter requesting information as to the covering capacity of their different grades of paint. As you will notice by the table, these figures have been scaled down, owing to the fact that in our practice paint did not cover so large an area as was claimed by the paint manufacturing companies. The area in each length of truss to be covered with paint was found by actual calculation in a large number of cases, and the number of gallons to each size span for first and second coat was thus determined. We should be very much pleased to have any one in possession of data to make through your columns what criticisms they can on the amounts given in the table. Of course, these figures are given for very fine ground pigment in linseed oil, which will cover considerably more than ordinary market paints. Red lead is used with lamp black according to the B. & O. formula. The cost of labor in painting is probably too high, but this is usually a small item in the cost of the structure. Very truly, C. E. Fowler,

Chief Engineer Youngstown Bridge Co.

Youngstown, O., Jan. 17, 1896.

## AMOUNT AND COST OF PAINT REQUIRED FOR PAINTING BRIDGE SPANS.

(Compiled by C. E. Fowler, Chief Engineer, Youngstown Bridge Co.)

Highway, 16 ft. wide; 90 lbs. per sq. ft.

| Span Length, ft. | Wight of Span, lbs. | Area to be painted, sq. ft. | Number of gallons required for each coat. | | | | | | | | | | | | Cost per coat. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Oxide iron | | Red lead | | White lead | | Graphite | | Asphalt | | Carbonizing coating | | Material per 100 lbs. wt. of bridge. | Labor per coat. |
| | | | Coat. 1st. | Coat. 2d. | Coat. 1st. | Coat. 2d. | Coat. 1st. | Coat. 2d. | Coat. 1st. | Coat. 2d. | Coat. 1st. | Coat. 2d. | Coat. 1st. | Coat. 2d. | | |
| 20 | 1,800 | 400 | 1 | ¾ | ¾ | ½ | 1 | ¾ | 1 | ¾ | 1½ | 1 | ¼ | ¼ | $ .025 | $2.50 |
| 40 | 5,200 | 800 | 1½ | 1¼ | 1¼ | 1 | 1¼ | 1¼ | 1½ | 1¼ | 3 | 1½ | ¾ | ½ | .015 | 4.25 |
| 60 | 10,200 | 1,400 | 3 | 2 | 2 | 1½ | 3 | 2 | 3 | 2 | 5 | 3 | 1½ | 1 | .015 | 6.80 |
| 80 | 16,800 | 2,200 | 4½ | 3 | 3 | 2¼ | 4½ | 3 | 4½ | 3 | 7 | 4½ | 2¼ | 1½ | .013 | 10 20 |
| 100 | 25,000 | 3,000 | 6 | 4¼ | 4¼ | 3 | 6 | 4¼ | 6 | 4¼ | 10 | 6 | 3 | 2 | .012 | 14.50 |
| 120 | 34,800 | 3,800 | 7½ | 5½ | 5½ | 4 | 7½ | 5½ | 7½ | 5½ | 13 | 7½ | 3¾ | 2½ | .012 | 18.80 |
| 140 | 46,200 | 5,400 | 11 | 8 | 8 | 5½ | 11 | 8 | 11 | 8 | 18 | 11 | 5½ | 3½ | .012 | 27.20 |
| 160 | 59,200 | 8,000 | 16 | 12 | 12 | 8 | 16 | 12 | 16 | 12 | 27 | 16 | 8 | 5½ | .013 | 41.00 |
| 180 | 73,800 | 10,000 | 20 | 14 | 14 | 10 | 20 | 14 | 20 | 14 | 33 | 20 | 10 | 7 | .013 | 47.50 |
| 200 | 90,000 | 12,000 | 24 | 17 | 17 | 12 | 24 | 17 | 24 | 17 | 40 | 24 | 12 | 8 | .013 | 57.80 |
| 220 | 107,800 | 15,000 | 31 | 21 | 21 | 15 | 30 | 21 | 30 | 21 | 50 | 30 | 15 | 10 | .014 | 71.50 |
| 240 | 127,200 | 18,000 | 36 | 25 | 25 | 18 | 36 | 25 | 36 | 26 | 60 | 36 | 18 | 12 | .014 | 88.40 |
| 260 | 148,200 | 21,000 | 42 | 30 | 30 | 21 | 42 | 30 | 42 | 30 | 70 | 42 | 21 | 14 | .014 | 102.00 |
| 280 | 170,800 | 24,000 | 48 | 35 | 35 | 24 | 48 | 35 | 48 | 35 | 80 | 48 | 24 | 16 | .014 | 119.00 |
| 300 | 195,000 | 28,000 | 56 | 40 | 40 | 28 | 56 | 40 | 56 | 40 | 90 | 56 | 28 | 19 | .014 | 136.00 |
| | Single track railway. lbs. | sq. ft. | | | | | | | | | | | | | | |
| 80 | 60.000 | 4,800 | 10 | 7 | 7 | 5 | 10 | 7 | 10 | 7 | 16 | 10 | 5 | 3 | .008 | 24.00 |
| 100 | 85,000 | 6,800 | 14 | 10 | 10 | 7 | 14 | 10 | 14 | 10 | 23 | 14 | 7 | 5 | " | 34 00 |
| 120 | 112.000 | 8 960 | 18 | 13 | 13 | 9 | 18 | 13 | 18 | 13 | 29 | 13 | 9 | 6 | " | 44.00 |
| 140 | 150,000 | 12,000 | 24 | 17 | 17 | 12 | 24 | 17 | 24 | 17 | 40 | 24 | 12 | 8 | " | 58.00 |
| 160 | 185,000 | 15,000 | 30 | 21 | 21 | 15 | 30 | 21 | 30 | 21 | 50 | 30 | 15 | 10 | " | 72 00 |
| 180 | 226,000 | 18.080 | 36 | 26 | 26 | 18 | 36 | 26 | 36 | 26 | 60 | 36 | 18 | 12 | " | 83.50 |
| 200 | 270.000 | 21,600 | 43 | 31 | 31 | 22 | 43 | 31 | 43 | 31 | 72 | 43 | 22 | 14 | " | 105.00 |
| 220 | 319,000 | 25.520 | 51 | 36 | 36 | 25 | 51 | 36 | 51 | 36 | 85 | 51 | 25 | 17 | " | 122.00 |
| 240 | 375,000 | 30.000 | 60 | 43 | 43 | 30 | 60 | 43 | 60 | 43 | 100 | 60 | 30 | 20 | " | 146.00 |
| 260 | 429.000 | 34.320 | 69 | 49 | 49 | 35 | 69 | 49 | 69 | 49 | 115 | 69 | 35 | 23 | " | 167.00 |
| 280 | 490.000 | 39,200 | 78 | 56 | 56 | 39 | 78 | 56 | 78 | 56 | 130 | 78 | 39 | 26 | " | 190.00 |
| 300 | 555,000 | 44,500 | 89 | 63 | 63 | 45 | 89 | 63 | 89 | 63 | 148 | 89 | 45 | 30 | " | 215 00 |
| | 1-gallon Covers: | | | | | | | | | | | | | | | |
| | Sq. ft..... | | 500 | 700 | 700 | 1,000 | 500 | 700 | 500 | 700 | 300 | 500 | 1,000 | 1,500 | | |
| | Cost per gallon.. | | $.50 | | 1.25 | | .85 | | .70 | | .40 | | 1.50 | | | |

In painting corrugated iron, add 10% to surface to allow for corrugations.
Weight of iron buildings may be assumed at 12 lbs. per sq. ft., or assume 1 sq. ft. of surface to be painted for each square foot of floor area.

## The Proper Design for the Intersection of Two Circular Brick Sewers.

Sir: Will you kindly have answered through the columns of your paper the following questions in regard to the proper design of an intersection of two circular brick sewers?

Given one sewer 9 ft. inside diameter, with 12-in. walls, coming into another sewer 14 ft. inside diameter, with 20-in. walls; the original surface of the ground about on a level with the top of the smaller sewer; and the invert or spring line of the two coinciding at the intersection; 2 ft. of covering consisting of broken stone to be placed on top of sewers.

(1) What would you consider to be the smallest angle of intersection allowable, to be in accord with safety or good engineering?

(2) Would you consider an angle of 35° to be in such accord?

(3) If the lay of the ground were such as to render so acute an angle necessary, would you consider it essential to put any provision in the specifications governing the bond of the work, the strength of the mortar or the length of time for supporting the arches by the wooden framework before allowing them to support themselves, other than you would have governing the ordinary construction of brick arches.

(4) Would you consider the omission of any such especial provisions in the specifications as bad engineering.

(5) Would there or not be severe tensile stresses due to the design mentioned above.

If you can agreeably to yourself answer these questions, I will be greatly obliged. I have made a report on such a design as above set out, and desire to know if my opinions are substantiated. Very respectfully,

Herman D. Ruhm,
Engr. Nashville Sewerage Co., ex-Secy. Eng. Assoc. of the South.

Nashville, Tenn., Jan. 29, 1896.

(We refer our correspondent's question to our readers.—Ed.)

## Wood and Asphalt Paving.

Sir: The statement has come to my attention that on some of the streets having the heaviest traffic in London and Paris wooden blocks, laid on a base of hydraulic cement concrete, have been substituted for asphalt pavement, and found very satisfactory.

If you or any of your readers can inform me where to get exact information as to the construction of this pavement, its life under heavy traffic, cost, etc., I shall be very much obliged to you. Yours truly,

James B. French,
Chief Engineer's Office, Chesapeake & Ohio Ry.

Richmond, Va., Jan. 30, 1896.

(The use of wooden block paving on concrete foundations is very general in London and other large European cities, but the only particular case in which this paving has been substituted for asphalt, of which we can now find mention, is in London. In a paper on "Carriageway Pavements for Large Cities," in our issue of March 29, 1894, the secretary of the Improved Wood Pavement Co. is quoted as follows: "This year we are paving for the Strand district, 22,000 sq. yds.; for the Hackney district, 20,000 sq. yds.; for the St. George's district, 26,000 sq. yds.; various districts, 20,000 sq. yds., all at present macadam or stone pitching, and in one case asphalt." The reason of the change in this case is not given. The expensive but hard Australian wood paving blocks are now being introduced in this country by the American Torbay Karri Wood Pavement Co., 114 Fifth Ave., New York, and by McLean Bros. & Rigg, 52 New St., New York, the former using karri, and the latter jarrah, both being of the same species, as already described in our columns, and the latter being said to be the harder of the two.—Ed.)

## The Westinghouse Air Brake Co. vs. The Boyden Brake Co.

Sir: The issue by the Boyden Brake Co. of a circular, dated Dec. 31, 1895, in which that company asserts, among other misleading statements, that the decision of the Fourth Circuit Court of Appeals in favor of that company is final, makes it necessary for us to state that the United States Supreme Court has, upon petition of our counsel, based upon a few of the serious errors involved in that decision, granted a writ of certiorari directing the case to be sent up to it for revision and final judgment.

The Boyden Company's statement was manifestly prepared before the Supreme Court granted the writ of certiorari, and it will thus be seen that that company is not yet finally authorized to make and sell quick-action air-brakes without liability for infringement of our patent rights.

We have never doubted that the final decision in this

case will reaffirm the validity of our pioneer quick-action air-brake patent (No. 360,070, the one in dispute), as already established in other courts; for Judge Hughes, in his decision in favor of the Boyden Brake Co., says:

That this invention of Westinghouse, thus undefined (the Court then referring to the second claim), is one of the highest value to the public, and that it is a pioneer one in the art of quick-action brakes is not denied, and is conceded. It is conspicuously one of those pioneer inventions which entitle the proprietor to a liberal protection from the courts in construing the claim:

This statement is in accord with the opinions of other Courts, which have, in each instance, conceded and affirmed the pioneership and value of this invention.

In each of the three previous decisions in favor of this patent, the second claim has been upheld and has not, in any manner, been held to be insufficient, even in any technical sense, to fully cover the invention, and we therefore the more strongly feel that our confidence in the ultimate determination of this litigation in our favor is well founded.

The Boyden Brake Co. has issued an illustration and description of a new form of quick-action triple valve, which, it states, was subjected to a satisfactory rack test at Altoona by the Air-Brake Committees of the Master Car Builders' Association. This new valve has not hitherto been the subject of litigation under our patents, and has never, to our knowledge, been commercially used or tested. We believe that the construction of this valve comes clearly within the claims of one of our patents, and we have promptly brought suit against the Boyden company, to restrain that company from making and selling this new valve.

It will not be out of place to call attention to the fact that railway companies have, in numerous instances, been misled by the statements of various parties manufacturing brakes, in infringements of our rights, and the loss inflicted upon those who have purchased brake apparatus in reliance upon those statements has already been very great. We feel convinced that we are fully justified in believing that our patents fully cover all of the forms of quick action brakes which have so far been offered for sale, and that the Courts will finally so decide. The Westinghouse Air-Brake Co.,

H. H. Westinghouse, General Manager.

Pittsburg, Pa., Feb. 3, 1896.

(The decision of the Fourth Circuit Court of Appeals, above referred to, was noted in our issue of Nov. 21, p. 350.—Ed.)

## The Air-Chamber Electric Railway Conduit at Vienna.

SIR: It has been remarked many times that what are really American inventions have to be introduced into this country from Europe, and the following statement bears this out. After several attempts and nearly as many failures our street railways are now just introducing underground trolley systems, years after Europe had at least two in use—at Blackpool and Budapest. These systems are very expensive, costing at least $45,000 per mile of track when complete with feeders, etc., owing to their great depth below the surface of the street, and the nature of the materials used in their construction. With the slotted conduit with bare conductors, as in the Lenox Ave. line in New York, the Metropolitan (9th St.) line in Washington and other systems, it is not possible to reduce this cost to any material extent. About August, 1894, an experimental conduit was laid in Germany, near Berlin, which departed radically from the Budapest, Lenox Ave. and like systems (in which the great size of the conduit is relied upon to keep water, snow and ice away from the wires), depending on a longitudinal water-sealed air chamber for keeping water from contact with the bare wire, and brought down the size of the conduit to 7x5 ins. outside measurement. These trials were completely successful ("Elek. Anzeiger," Berlin, Nov. 4, 1894, and April 4, 1895). The nature of the new conduit is indicated by the title, "air-chamber trolley conduit," and is described as follows by the "Elek. Anzeiger":

There is a slotted conduit made up of sections, the top being formed like an inverted box, with the object of preventing any water in the conduit from extending into this box by virtue of the air in it. The conduit and even the street may therefore be immersed in water, but the air confined in this box will keep the water from reaching the wire which is supported therein.

The technical journals of last summer noted the fact that several lines in Vienna were to be equipped for electric traction, and the "Elek. Anzeiger," of Nov. 21, 1895, contains a list of the bidders. The first one named is Mr. E. Lachmann, the man who carried through the test of the air-chamber trolley conduit above noted, and the other bidders were as follows: Adolph Springer, Vienna; Kontinentalen Gesellschaft fuer Elektrische Unternehmungen, Nuernberg; Allgemeinen Elektricitats-Gesellschaft (General Electric Co.), Berlin; Wiener Bankverien, Vienna; Neuen Wiener Tramway-Gesellschaft mit der Anglobank und Siemens & Halske, Vienna; Bau-unternehmung Ritschel & Co., Vienna, mit der Union Elektricitats-Gesellschaft, Berlin; Stadler Stephan, Vienna.

Mr. Lachmann writes me under date of Jan. 4, 1896, that he was successful in the bidding and that a contract to equip a line with the air-chamber trolley conduit system was awarded him, the line to be finished in April next. If this is satisfactory to the authorities, he will equip all the other lines likewise. The fact that Mr. Lachmann was victorious over such great competitors as those named speaks volumes for the air-chamber trolley conduit.

The introduction of this system in Europe is tantamount to its subsequent introduction here, for it is very much cheaper to construct than any of the other systems named above, and works just as well when immersed in water as at any other time, something no other system, with either open or closed conduit, will do. And yet an American patent on this system antedates by two years the beginning of Mr. Lachmann's test in Europe, and the system was illustrated in your issue of Oct. 20, 1892. It is hoped that we may equip a road in this country the coming summer. R. W. Barkley.

Temple Court, New York city, Jan. 20, 1896.

## Cylinders for Acetylene Gas.

Sir: From Dr. Birchmore's article in your issue of Jan. 30 I quote the following:

There remains but one way to handle the product—compress it and sell it in bottles. This can be readily done, and is a way both simple and safe, it having already been proved that the bottled compressed gas is as easy to care for as an equal amount of water. By means of valves of the sort used on carbon dioxide bottles, the pressure of the escaping gas can easily be regulated. At the present state of the art this seems to be the best way to handle ethine.

The Size of Bottle.—It is asserted that in an average house the consumption of gas in Brooklyn is about 10 ft. per night per burner, and as the usual burner is a 5-ft. tip, it may be assumed that the average gas lamp is to be burned two hours per night. A bottle, then, which would hold 10,000 cu. ft. at the needed pressure would hold enough for three months, even if the consumption were as great as that of gas, and as the amount used would be only 25% that of ordinary gas, a holder of very moderate dimensions would do for a month's supply.

This easy way of dealing with the matter of storing and handling the gas in cylinders is a striking peculiarity of the propaganda.

The writer had occasion some time since to ascertain whether a small cylinder of about ½ cu. ft. capacity could possibly contain the amount of gas that the company's orator in Philadelphia had declared it to hold. A little calculation showed that if the gas was present as stated, its density must be nearly equal to that of cast iron.

In the present instance Dr. Birchmore suggests storing a month's supply of gas for household use in a bottle "of very moderate dimensions." This supply he indicates as exactly 833 cu. ft., but as this is close figuring and a little margin is desirable, let us consider what kind of a gas holder is required for 1,000 cu. ft. of acetylene gas.

The weight of acetylene gas is recorded as 1.1621 grammes per liter, equal to .07256 lbs. per cu. ft. It appears, then, that the gas alone will weigh 72.5 lbs. per 1,000 ft. It is also recorded that it is liquefied at 67° F. under a pressure of 40 atmospheres, and that the specific gravity of the liquid is about 0.55 (Suckert in "Journal of the Franklin Institute," No. 833).

The volume of 1,000 cu. ft. of liquid gas (72.5 lbs.) in a liquid form would thus be 2.1 cu. ft. With an inside diameter of 5 ins. (and none of the acetylene cylinders which the writer has seen were larger), this would require a cylinder 15 ft. long. If, however, we assume 7 ins. diameter inside, which is quite large enough for high pressures, the length would be nearly 8 ft. inside, or quite 8 ft. 6 ins. outside, and it could not safely weigh less than 225 lbs., or with its contents of gas 300 lbs.

To make a lighter cylinder would indeed be practicable to sustain 40 atmospheres, but the critical point of the liquefied gas is stated to be 98° F. (Suckert, in "Journal of Franklin Institute"), and at this temperature there would be an enormous increase in pressure, the exact amount of which is, however, probably still undetermined. It would clearly be unsafe to furnish or use cylinders which would not be entirely safe at temperatures of at least 110° F. Hence this estimate of 300 lbs. as the weight of cylinder and contents is believed to be a conservative one.

Now, a cylinder 8½ ft. long and weighing 300 lbs. is hardly a "bottle" or a trifling affair to be handed down one's cellar stairs once a month. But even this statement of the case is entirely too favorable. The fact which the acetylene gas people must face is this—that it is entirely unsafe to liquefy a gas whose critical point is only 98° F., and subject such cylinders to the incidents of transportation and of ordinary use in dwelling houses. It has been found necessary to adopt this view in the case of nitrous oxide for dentists' use, and it will be necessary with acetylene.

If, then, 40 atmospheres at 70° F. is the limit of compressibility, the use of acetylene in cylinders is even more impracticable than its distribution by tanks and street mains. Frederick H. Lewis.

406 Locust St., Philadelphia, Pa., Feb. 3, 1896.

## Failures from Freezing Mortar.

SIR: In reference to your editorial note of Jan. 16 on the failure of the masonry tower at Lena, I think your assertion, "that if a green mortar of natural cement be frozen, it will disintegrate to a greater or less degree upon being thawed," is a little too broad. I have in my practice, laid all classes of masonry in freezing weather and have a very large measure of success therein.

During the construction of the Chicago, Burlington & Northern R. R., I was personally at the Chippewa River bridge during the construction of the piers. These were all laid with Milwaukee cement. Several of them were entirely built during periods when the temperature was never above zero. Subsequent examination showed these to be fully equal to piers laid up in any season. When the mortar was dug out of the joints for pointing it was found to be very hard.

During this time I made an extensive series of tests on briquettes, both neat, from the mortar box, and with sand in the laboratory. All were mixed and molded warm, and some placed immediately in the open air, where they froze at once, and remained frozen for a week, then were thawed in cold water, and broken as soon as thawed. Some of each lot were set in water, as in ordinary tests. In every case the frozen ones were as good as, or better than, those set in water. Parenthetically I will say that numerous experiments were made in which salt or salt water was used. In all of these, whether frozen or not, there was a marked decrease in strength. From these tests and the results of the work on these bridge piers I concluded that cement masonry laid infreezing weather, with Milwaukee cement, and kept frozen for several days, was equal to that laid in the most favorable weather. Subsequent experience has borne out this conclusion. I would not hesitate to recommend the laying of most important work in the northern portions of this country in winter.

My experience does not, however, justify laying masonry of any kind in freezing and thawing weather. In a case like Lena I should have protected the work from the sun, and should have tested the cement before it went into the work. Cement tests should be in all cases as near approximations as possible to the actual conditions of use

My theory for the failure at Lena can be read between the lines above and is sustained by the report in your valuable paper. The south side, where the sun had acted, was a complete failure, while the north side still stands. There have been but few days here at Dixon, and I can recall no period of three days together this winter up to Christmas, when it did not thaw to some extent in the sun at noonday. Yours truly,

L. B. Merriam.

Dixon, Ill., Jan. 21, 1896.

(Our note, perhaps, did not make our own views sufficiently plain. In this particular case the failure was due rather to the class of masonry and to the unequal bearing brought upon the stone by the thawing of the mortar on one side of the tower than by the freezing of the mortar itself. The experiments of Trautwine and of others agree with the experience of our correspondent; and for well-bedded ashlar masonry, with a thin layer of cement of even thickness, there is no special danger in laying mortar in freezing weather; for even if it softens when thawing occurs, it will settle evenly, if at all. But in the case of rubble masonry, if the mortar becomes soft by thawing throughout the structure, the superimposed weight tends to readjust itself; and wherever the volume of mortar is relatively large this weight is liable to concentrate upon projecting points or isolated beds, and cracks or total failure follow. At Lena the south face of the tower thawed out, while the north side still remained frozen; and this condition aggravated the cause of failure by favoring a diagonal instead of a vertical settlement. While our correspondent does not say so, we assume that his bridge piers were well cut, coursed masonry; and in his case the mortar layer was thin, and what little settlement might have occurred was vertical.—Ed.)

## Smoke Prevention and Smokeless Furnaces.

Sir: I have been very much interested in the article and editorial about smoke prevention in your issue of Jan. 2, 1896. It is a fixed fact that increased economy of fuel and virtually the complete prevention of smoke can be reached by comparatively simple means, but no matter what the device is, the conditions necessary for complete combustion must be met. I would qualify somewhat these conditions as stated in your editorial, and offer them as follows:

(1) A good draft, not less than ½-in. of water in all weather.

(2) Open grate bars, the openings being fully 50% of the total grate area.

(3) Ample air admission over the fire, varying with the kind of coal used and the rate at which it is burned.

(4) Intimate admixture of the air and volatile gases under conditions of heat.

(5) Ample flameway before the burning gases reach the tubes.

(6) Ample heating surface in boiler shell and flues to absorb the heat developed.

If the first, second, fifth and sixth conditions be present, the adaptation of the third and fourth can be simply and cheaply made in most cases, and as a rule, without using any particular device. If any of the others are missing, it is a question of additional expense to supply the deficiency, and in some cases only partial success can be reached short of a complete rebuilding of the plant.

I have also read with interest the letter of Mr. Whitehead, of the Dorrance Co. I think he is by no means alone in his idea of the value of a restricted grate surface, or, to express the same meaning in another way, an increased heating surface as compared with the grate area. I have seen, however, this condition carried to excess and grates constricted so much that they would not furnish heat enough for the size of boiler used. It will be noticed in the test of the Dorrance furnace referred to, that there were 59 sq. ft. of boiler heating surface to 1.8 sq. ft. of grate. This agrees very closely with estimates I have made from time to time calling for 55 sq. ft. boiler heating surface to 1 sq. ft. of grate for ordinary tubular boilers; and good draft water tube boilers often have as high as 70 sq. ft. of heating surface to 1 sq. ft. of grate. Experiments have shown in such cases the flue gases entering the chimney at only 20° to 50° higher temperature than the water temperature in the boiler.

There is one feature to which you refer which is an important one, and that is that each plant has to be considered as a study by itself. This is one direction in which many introducers of so-called smoke preventers fail. There is no "cure all" for the varied ills that boiler and furnace plants are heir to, but an intelligent study of each case will always show a chance for improvement and in a majority of cases will bring about comparatively complete results.

C. M. Higginson,
Chicago, Burlington & Quincy R. R.

Chicago, Ill., Jan. 20, 1896.

Sir: We notice in your issue of Jan. 2, under the head of "Smoke Prevention and Smokeless Furnaces," an item relating to the Thomas smokeless furnace and fuel economizer, owned and controlled by this company. In this article you make the following statement: "This furnace is stated to have shown a saving of 20% in fuel over the ordinary grate bars, in tests made at the Ellsworth Building, Chicago." We beg to say that, these tests made at the Ellsworth Building, which lasted several days, were not made against the ordinary grate bars, as stated in your article, but against the Dorrance furnace; and the saving shown by the Thomas smokeless furnace over the Dorrance furnace was 19.8%, instead of 20%, as stated. We will say further that the conditions of these tests, which were made under the supervision of the engineer of the plant, were as near identical as was possible to have them. The coal used in both cases was the same, and the work performed by the boilers practically the same, the tests being made as near together as was possible after altering the furnaces from one constraction to the other.

Regarding tests made at other places against the ordinary grate bars, we have a record of 30% saving shown. These latter tests were made under our own supervison; but in the case of the Ellsworth Building the tests referred to were evaporative tests, and were carefully made by the engineer in charge of the building, as our furnaces were put in there under a guaranty of 10% saving, and of course they wished to ascertain very definitely if our guaranty was fulfilled before paying for the furnace. Trusting you will take notice of this correction, we remain, yours very truly,

Engineering Improvement Co.,
T. H. Williams, C. E.,
Secretary and Chief Engineer.

Chicago, Ill., Jan. 15, 1896.

## Relative Advantages of Hand and Mechanical Stoking.

Sir: In your issue of Jan. 2, Mr. W. W. Whitehead, in a letter on "The Relative Advantages of Hand and Mechanical Stoking," attempts to favorably compare hand firing with mechanical firing, but an investigation of the differences in the two methods pointed out, and others which he has not mentioned, will all show to the advantage of mechanical stoking, and explain its marked success and adoption in place of hand firing, not only for all types of boilers, but in nearly every kind of furnace where coal is burned—puddling and heating furnaces, kilns, forge fires, etc. The term "automatic stoker" has been used several times by Mr. Whitehead, but as there is no automatic stoker on the market it is assumed that the mechanical stoker has been meant and that the terms have been confounded.

At the outset of the letter an argument is presented to prove the advantage of small grate surface for hand fired furnaces, and in this many will agree. Since the underfeed stoker will burn more coal per square foot of area than any hand fired furnace, by Mr. Whitehead's own argument it must be admitted that in this respect the mechanical stoker is superior.

Mr. Whitehead's main objection to the mechanical stoker is due to its being without reason, and to him the only reasonable way of introducing coal to be burned is through the open fire than by a shovel. Here the waste begins which in the mechanical stoker is overcome. The green coal thrown upon the fire releases its volatile products. The inrushing cold air from the open fire door meets these products, and chilling the furnace walls in its passage carries them up the stack, causing a dense smoke. Holes are formed in the fire which is levelled by the "good fireman," but not until it has become so thin in spots that a surplus volume of air has been allowed to pass through and escape with its absorbed heat.

In the continuous underfeed stoker the coal, instead of being thrown upon the surface of the fire, is fed up from below and becomes very hot as it approaches the surface, throwing off its gaseous ingredients which, in passing through the incandescent fire, are met by a supply of air and thoroughly consumed, resulting in a smokeless stack. Mr. Whitehead states that the mechanical stoker being devoid of reason, cannot fill up the holes which are made in the hand fired furnace by the unequal burning of the coal. He is mistaken in that, however, for the underfeed type would certainly do so if the holes were once formed; but it does far better in preventing their formation. Again he says: "Remember, the conditions in the furnace are continually changing. Does the automatic stoker accommodate itself to these variations and act accordingly?" This should have read: "Remember, the conditions in the 'hand fired' furnace are continually changing." Here is another one of the mechanical stoker's winning features—it prevents by its continual action these variations. In its operation the rise and fall of the steam pressure are met by a corresponding increase or decrease in the amount of coal and air introduced. These is another loss in a hand fire not found in the improved method, and that is from what is commonly called ash. Nothing comes from the underfeed stoker but clinker, with not a trace of combustible matter; but a large percentage of the so-called ash from a grate-fire is coal. Advantage is taken of this in making some high evaporation tests. Hydro-carbon gases, distilled from the coal, are by expert manipulation more or less consumed. These gases, although very light, are much higher in heating value than the remaining carbon for equal weights. The coal, after giving up its gaseous products, is allowed to fall into the ash pit, and is weighed as ash. This coal has given up much of its heating value, but its weight has been but little decreased; and it is evident that an ordinary evaporation per pound of coal will, in this way, be made very high per pound of combustible.

In answer to the query: "Why do large boiler companies guarantee the efficiencies of their boilers only when hand fired," I would ask why some of the largest and best boiler companies recommend stokers, and others manufacture their own? It is because they desire their boilers to prove economical under daily working conditions.

Mr. Whitehead gives an evaporation of 8 lbs. of water per pound of screenings as a result of a hand fired test made at the Rookery Building, Chicago. At the Cincinnati Union Depot five 66 in. x 16 ft. tubular boilers, equipped with the American Underfeed Stoker, gave an average of 10,186 lbs. of water per pound of slack.

Another interesting comparison can be made from the tests conducted by the Piqua Rolling Mill Co., Piqua, O., at their mill, which test extended over several weeks. Two adjacent identical puddling furnaces and their waste-heat boilers were equipped, one for hand firing and the other with a mechanical stoker. The stoker showed a gain of 16% in the output of iron and 20% in the evaporation of water per pound of coal. These, however, were not the only gains, as the waste of iron was less and the quality better, showing that free oxygen did not escape through the stoker and into the puddling chamber, as in the hand furnace.

It is remarkable that Mr. Whitehead should believe that operations performed by hand cannot be equaled by mechanical means, when the past and present afford so many well-known examples of the successful substitutions of machinery for hand operations.

Yours truly, W. R. W.

Dayton, Ohio, Jan. 29, 1896.

## Proper Consistency of Concrete After Mixing.

Sir: That the proper consistency of cement mortar is an important question is evident by the many comments made recently in different engineering journals, both editorially and by correspondents. It is my opinion that this question of the proper per centage of gaging water is really the most vital and important of all points concerning cement and concrete; and for this reason I wish to continue the discussion through the columns of your valuable paper.

All engineers who have personally made any extensive investigations in cement by means of briquettes are aware of the difficulty of securing uniformity of results—that is, getting all of the briquettes in any one set, made at the same time, of the same material, and treated exactly alike, to break with the same strain. Inexperienced workmen will make differences of 100%, and the best and most careful experimenters seldom ever succeed in reducing this error to less than 5%. These differences arise from irregular mixing of the materials, inaccurate weighing, lack of uniformity of cements, careless breaking, irregular speed of testing machines, varying per centages of water, and many other points that will no be thought of until the actual work begins.

While recently undertaking a comprehensive series o experiments to determine the best size of sand to be used for cement mortar, I first found it necessary to investigate all of these irregularities so that I might be able to eliminate as many of them as possible. For the determination of the relative values of different kinds and sizes of sands an error of 10% in any one series would be fatal to the object sought. During this investigation it became evident that the greatest source of error was due to irregular per centages of water. The fact that some cements, and also some sands, required more water than others added another complication to the matter. Generally speaking natural cements require more water than Portland to get the same consistency of mortar, and fine sands more than coarse. But to get the same stiffness in all batches of mortar is simply impossible. The same weight of a given cement and sand, mixed with the same per centages of water, will not always give a mortar that appears to have the same consistency; neither will the briquettes always give the same strength after being mixed and broken with the utmost care. The only way to establish anything in this line, then, is to get together an immense mass of evidence, depending on the law of probable errors to strike a proper mean, and that is what did in my sand tests.

This summer a commission of eminent engineers was appointed in Europe to formulate "Uniform Methods of Testing Building Materials," and it is to be hoped that something of the kind may be done in this country to supplement or confirm the work of this commission. Although there is a sad lack of uniformity on all points concerning the proper methods of testing cement, the greatest and most dangerous variation lies in the varying customs and ideas as to the amount of water to be used.

It is my belief that most of the failures in cement sewer pipes in this country are due to the use of small per centages of water in their manufacture. They are usually made of mortars having about 25% of water to the cement used. This custom has come about from two facts: (1) on account of the greater ease of compacting and handling very dry mortar; (2) on account of the fact that many engineers believe and advocate that just enough water for chemical purposes is sufficient in cement mortars.

This fact I wish to deny, and to charge these engineers with being responsible for so many failures in cement sewer pipe. It is my belief that if these pipes had been manufactured with mortars in which about 45% of water to the cement used, or say 25% to the sand and cement in 1 to 1 mixtures, there would not have been recorded in the past so many failures where cement sewers were used. Of course this is partly theoretical reasoning on my part. This much has been proved, however, that dry mortars with 25% to 30% of water, or about the consistency of moist snow, are not as strong as mortars where higher per centages of water are used.

The tests which I sent to Engineering News and which were published in your issue of Dec. 12, 1895, were only intended to illustrate the effect of slight changes of per centages of water, but as they also tended to shed some light on the question under discussion, I sent them to you believing that engineers generally would take them for what they were worth. It was not pretended that they would settle this entire question.

Mr. Alden H. Brown, in his letter published in your issue of Jan. 9, 1896, besides comments on my tests mentioned above, makes a plea for dry mortar. In regard to the tests I would refer him to the report of the Chief of Engineers, U. S. A., for 1894, pp. 2332 to 2335, where he will find a set of tests made especially for determining the best per centages of water to be used with different cements. The same general principle which I have before stated is here brought out and very conclusively proved. Of the references given by Mr. Brown (Eng. News, Feb. 7 and Nov. 21, 1891), the last is a work on the use of salt water with cement without any reference to the per centages, and the first is a paper on cements in general by Prof Eagler. What these have to do with the subject under discussion I cannot see, except that the professor casually mentions that it is best to use about 50% of water to the cement employed. In this I heartily agree with him.

The "Engineering Record" has been also defending the use of dry mortars, and when called upon to substantiate its position makes (see its issue of Jan 4, 1896) a very weak defense, and quotes several authorities all but one of which are now out of date. The editor, however, mentions some valuable points for investigation, and if opportunity ever presents itself I shall certainly carry them out.

Yours respectfully,
A. S. Cooper, U. S. Asst. Engineer.

Savannah, Ga., Jan. 12, 1896.

## The Present Aspect of the Mississippi River Navigation Improvement.

Sir: The bill now before Congress authorizing Messrs. Samuels and Mason to maintain a navigable channel in the Mississippi River, at low water, from St. Louis to the mouth of the river, of 7 ft. in depth below Cairo, and of 6 ft. in depth between Cairo and St. Louis, this work to be independent of the work now in progress under the Mississippi River Commission, is a matter of no small importance. The support of a movement of this character would seem to involve some want of confidence in the methods employed by the Commission, at least so far as any early results are concerned. The passage of this bill may possibly carry with it the entire abandonment of the Commission and its work.

The Mississippi River Commission has now been in existence 17 years. It is composed of two civil engineers, one lawyer, one representative of the U. S. Coast and Geodetic Survey, and three members of the Engineer Corps of the Army, one of the latter of whom is president of the Commission. The secretary of the Commission, who is its executive officer, is a member of the Engineer Corps of the army, and the officers in direct charge of the improvements are also members of that corps. The Commission also makes its reports through the Chief of Engineers of the army, so that it work has represented almost exclusively the policy and methods of members of the U. S. Engineer Corps. Not until Col. Henry Flad, Past-Pres. Am. Soc. C. E., became a member of the Commission in 1889, did any civil engineer exert any marked influence upon the policy or work of the Commission. The appointment of this famous engineer to a membership on the Commission has marked a new epoch in its history.

The work of the Commission hitherto has been of three classes, the building of levees, the protection of banks, and the construction of channel contraction works, intended to narrow the channel in the wide places to a width of about 3,000 ft. The effect of the building of levees upon the tops of the banks on the improvement of low-water navigation has by some engineers always been regarded as detrimental rather than helpful; but at best the influence of levees on the improvement of the channel at low stages is extremely indirect and could only become appreciable after long periods of time, some of the claims of the Commission to the contrary notwithstanding. The protection of the banks is necessary to the maintenance of the efficiency of the contraction works constructed in the channel, so that these two parts of the general scheme of improvement are mutually self-supporting and necessary to each other. The effect of the contraction works as designed by the Commission on the depth of the low-water channel, when such improvements have been completely carried out, if they ever should be, at a probable expense of from one to two hundred million dollars, can only be estimated. A careful estimate made in the editorial columns of the "Railroad Gazette," April 22, 29, and March 6, 1887, was that by these means no greater navigable depths, at all stages, could be secured than 12 ft. up to Vicksburg, 10 ft. to Cairo, 8 ft. to St. Louis, 5 ft. to Keokuk, and 3 ft. to St. Paul. These prospective depths have by no means been reached as yet at any of these points in the river at the lower stages, and it is not at all likely that they ever would be exceeded by the methods hitherto employed by the Commission.

At this time there have been spent under the direction of the Mississippi River Commission about $23,000,000, of which $8,000,000 have been devoted to the building of levees. At first Congress refused to appropriate money for the building of levees, except the Commission would put itself on record to the effect that such levees were absolutely essential to the improvement of low-water navigation. After the Commission had done this repeatedly, appropriations were made by Congress, with the understanding that the building of levees was an essential part of river improvement. Of course there has always been a very strong pressure brought to bear both on Congress and on the Commission to devote money to the building of levees in the interest of the protection from overflow of the bottom lands bordering on the Mississippi River below Cairo. Doubtless it will ultimately appear that the cause of river improvement in the interest of navigation has greatly suffered by this great divergence of funds in the interest of the protection of swamp lands from overflow. One indication of the failing confidence on the part of the public in the methods of the Commission, is the introduction of this bill into Congress, authorizing Messrs. Samuels and Mason, of St. Louis, to proceed to obtain a low-water navigable channel in the river, independent of the work of the Commission. This bill has received the support of nearly all the commercial organizations in St. Louis, and is receiving hearty support from river men, and from other cities along the river. It is claimed that the methods of the Mississippi River Commission are too slow in obtaining results, and that before the river can be improved as they propose, the river traffic will have become practically extinct. Why they could not have foreseen this before, and have exerted themselves to counteract the influence of the levee interests in favor of the channel improvement proper, instead of endorsing absolutely the policy of the Commission in the building of levees, does not appear. They seem, however, at last to have realized the situation.

But the Mississippi River Commission itself seems to have at last awakened to the necessity of obtaining a low-water channel within the life of the present generation, and Col. Henry Flad has shown them how this can be accomplished. Several years ago the Commission consented to allow him to build an experimental dredge boat, which should be used at the lower stages of the river, to cut an incipient channel through or across a sand bar which had been built up by the preceding high water, this channel to be so located as to rapidly enlarge by the flow of the current through it, and thus become a navigable channel across the bar for the rest of that low-water season.* If a dredge boat could be designed with a large capacity, delivering the excavated material entirely beyond the channel itself, and to be operated by moving rapidly up stream across the bar, cutting a channel as it went, it was thought one such boat would be able to maintain navigable channels across all the sand bars which would develop in a considerable length of river, and that a sufficient number of such boats, (the Commission estimate that nine would be required), could maintain a good navigable channel throughout the entire length of river below St. Louis. These channels would, of course, be only temporary, as they would all be obliterated during the following high-water season, and the work would have to be done over again every succeeding year. This kind of an alternative the Commission were slow to accept, and they did not give to Col. Flad that hearty support in the preparation of his experimental dredge which a man of his experience and reputation had reason to expect. In fact the responsibility of this undertaking was thrown entirely and solely upon him, the chairman of the committee under whom he operated not even consenting to examine his drawings at any time, either before or after the letting of the contract for this novel and remarkable machine. For two years, Col. Flad gave his entire time to the preparation of the plans and to the construction of such a suction dredge, the only assistant allowed him being a mere draftsman, with no engineering ability. (Col. Flad is now 72 years old.) This work, however, has proved to be perhaps the greatest triumph of a long and successful career. This dredge, called the "Alpha," intended only as a working example to prove the practicability of the Colonel's ideas, has been a remarkable success. While it was not intended as a working dredge for the improvement of the river, it has kept a good navigable channel across four of the worst bars in the river below Cairo, throughout the entire low-water season of 1895, which was the worst on record. It is able to excavate 600 cu. yds. of sand per hour, and deliver it through a 36-in. pipe at a distance of 1,000 ft. It has worked as much as 120 hours continuously without stopping, has been in operation 70% of the time (day and night) during three of four months of low water in 1895, with no breakage or interruption worth mentioning. So very successful has been this experimental dredge in its capacity for excavation, and also so successful have been the experimental channels excavated by it, all of them having greatly enlarged and deepened by natural processes, that the Mississippi River Commission have adopted this method of temporarily improving the channel, while they intend also to carry on their more permanent improvement. They have already devoted $700,000 to this experimental work, and to the building of new dredges, one of which is now practically completed, and is intended to have a capacity of 1,000 cu. yds. per hour, while the contract for another, having a capacity of 800 cu. yds. per hour, is about to be let.

* It does not seem to be generally known that the bars are all built up during the high-water season, and the greater the flood volume, the greater the damage to the low-water channel.

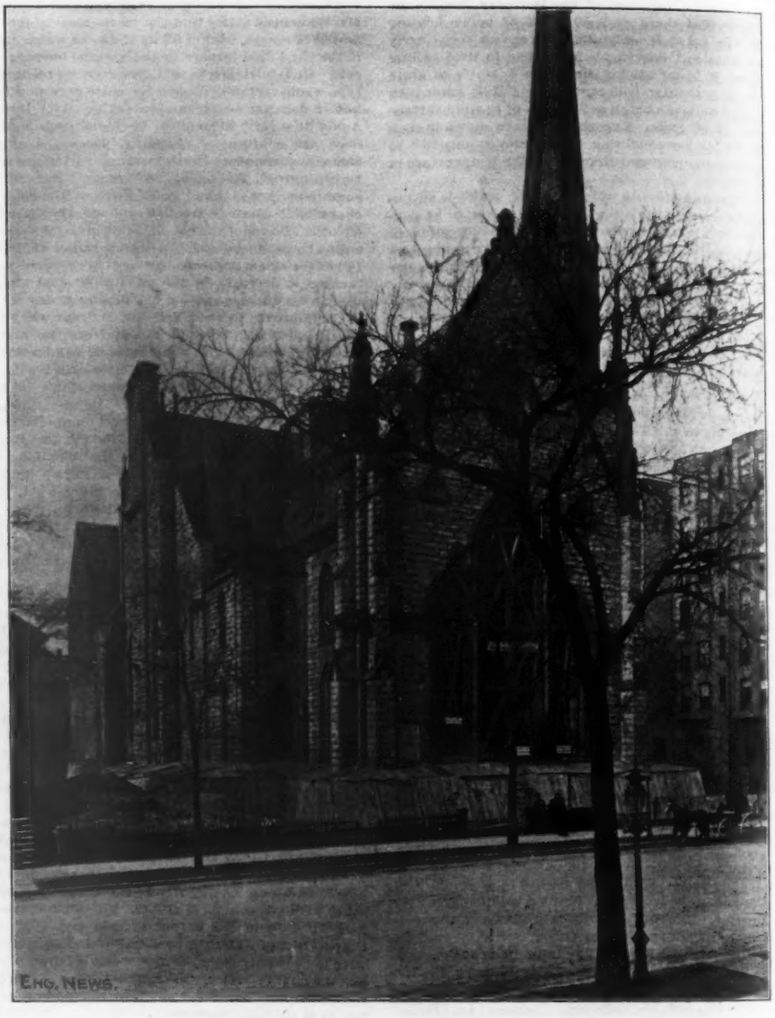



FIG. 1.—IMMANUEL BAPTIST CHURCH, MICHIGAN AVE. AND 23RD ST., CHICAGO.
Weight, 6,632 Tons; Moved 51 ft. Horizontally, and Raised 5½ ft. Without Cracking the Masonry.
H. Sheeler, Chicago, Ill., Contractor for Moving.

The success which has attended the work of Col. Flad's first or experimental dredge has pointed the way to a practical improvement of the low-water channel, and it is doubtless the success attending this experiment which has led to the Samuels-Mason bill now before Congress. While, therefore, this bill seems to antagonize the work of the Mississippi River Commission, the methods they would employ are doubtless the same which that Commission has now shown to be practicable and the methods also which they themselves propose to adopt. If this method, therefore, should fulfill its present promises, either under the auspices of the Commission, or under those of the private company, the professional credit for such success belongs solely to Col. Henry Flad, who was forced to assume the entire professional responsibility of the undertaking.

The question now before Congress is whether or not it is advisable to leave the work of improving the river to the Commission, or to let a separate contract to a private company, as proposed in the Samuels-Mason bill. Since the scheme of annually dredging a provisional channel across sand bars, to be further enlarged by the current, has only during the past season been proven practical and efficient, the Mississippi River Commission are as able as a private company to employ this system to advantage, and to secure from it all the results it is capable of giving. In fact it has already become their policy to build these boats and operate them, to the full extent of their present appropriations. If Congress would give to the Commission, therefore, the money which it is now proposed to give in this bill to private individuals, it would seem that the Commission should secure from it all the advantages which could come from its expenditure through any other channel. The past record of the Commission, however, does not stand them in very good stead at this juncture. They have always been more or less divided in their views as to the proper expedients to employ, and whether or not they would now operate the new method so vigorously on the entire length of river below St. Louis, as to give a clear channel over this whole distance, may well be questioned. The necessity to do just this, at the risk of losing everything, is, of course, the strong feature of the Samuels-Mason bill.

There is no question but the work agreed upon to be done by Messrs. Samuels and Mason is well worth the money to be paid them under the terms of the bill, and if we are to judge of the future by the past, we may well conclude that some such private contract offers a greater assurance of success than to continue to rely on the work of the Commission. In going into such a contract with private individuals, however, Congress should call to its aid the best engineering advice, and make the terms of the bill such as to insure a successful compliance, and to provide against the company obtaining their annual stipend without having fully earned it.

The Mississippi River Commission might also be continued, in this case, and it might be made a part of their business to determine the matter of compliance on the part of the company. This is the most difficult part of the Congressional problem. Whether or not it is practicable to provide a sufficiently large surveying force, through the low-water season only, to fully determine the work of the company over the 900 miles of river from St. Louis to Vicksburg, is a serious question. We have had, it is true, too much "Congressional engineering," but if Congress will call to its aid the proper professional assistance, it doubtless could enter upon such a contract as is proposed, with security. There are strong arguments on both sides of this question, and it is to be hoped no hasty action will be taken.

J. B. Johnson, M. Am. Soc. C. E.
Washington University, St. Louis, Mo., Feb. 1, 1896.

## MOVING A STONE CHURCH BUILDING IN CHICAGO.

A feat in the moving of a building of more than usual interest to engineers has recently been accomplished in Chicago, Ill., and is illustrated herewith. The task consisted in moving the Immanuel Baptist Church, located at Michigan Ave. and 23d St., 51 ft. to the south and raising it 5½ ft. onto a new foundation. The movement was necessitated by the construction a few years ago of the Hotel Metropole flush up against the north wall of the church, completely shutting off its light on that side. The raising of the structure was not an essential part of the moving, but was deemed advisable, together with other changes, in order that all improvements which the age of the building had rendered necessary could be carried out at one time.

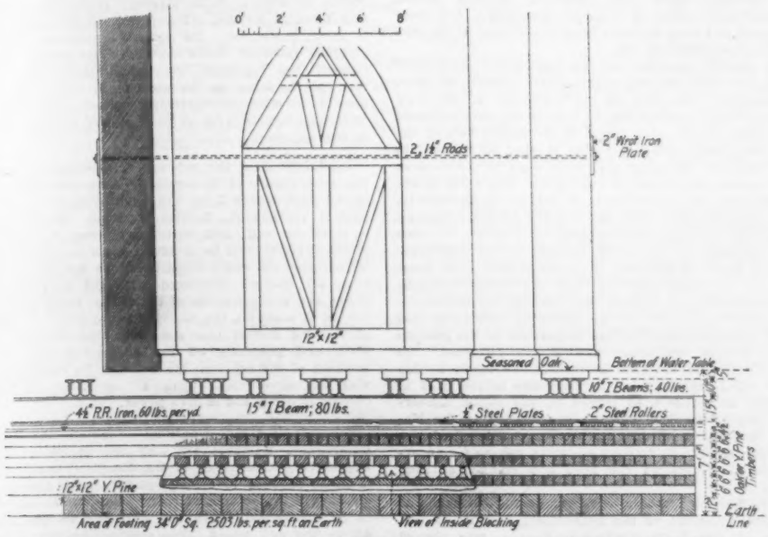

0' 2' 4' 6' 8'
2, 1¼" Rods
2" Wrot Iron Plate
12"x12"
Seasoned Oak
Bottom of Water Table
10" I Beams; 40 lbs.
4½" RR. Iron, 60 lbs. per yd.
15" I Beam; 80 lbs.
½" Steel Plates
2" Steel Rollers
Oak or Y. Pine Timbers
12"x12" Y. Pine
Area of Footing 34'0" Sq. 2303 lbs. per sq. ft. on Earth
View of Inside Blocking
Earth Line

FIG. 2.—LONGITUDINAL SECTION SHOWING SUPPORTS AND TRACK SYSTEM UNDER TOWER; IMMANUEL BAPTIST CHURCH, CHICAGO.

The church was constructed of stone masonry in 1869, and although the inside of the building had been burned out twice, the masonry was in a fair state of preservation. The dimensions of the structure on the ground are about 93x160 ft. and its height to the points of the main gables is about 100 ft. At one side and near the front there is a tower 24 x24 ft. at the base and 225 ft. high to the top of the spire. The estimated weight of the tower on this base is 1,430 tons, and the estimated weight of the whole building is 6,652 tons. It will be seen from the illustration (Fig. 1) that the front of the building is nearly cut in two vertically by the door and window, while there are several large openings in the walls at other points of the structure. These, of course, all weakened the structure for moving. Further than this, however, the inside of the church was nearly all given up to a single auditorium running nearly its whole length and extending 60 ft. high to the ceiling. This auditorium was spanned by arches carrying the roof.

The two principal problems which confronted the contractors, it will be seen, were (1) to carry safely the tall and heavy masonry tower on its small base without danger of detaching it from the remainder of the building, and (2) to brace and support the box-like auditorium so that its shell would not be crushed or distorted.

The bracing of the auditorium was first accomplished. A careful study was made of the roof trusses, framework and structural features, with the view of determining where stresses would occur tending to overthrow or distort the walls. Ties and struts were then placed to take such stresses. For example, the roof trusses spanning the auditorium were provided with ties to keep any thrust from coming on the outside walls, and all large openings in the outside walls were made solid by proper bracing (Fig. 1.) All weak points were strengthened by temporary ties or struts. It is impossible to describe this bracing in detail, for although one principle was followed everywhere, the conditions were different at nearly every point. The principle was simple. It was considered that the building in its normal capacity as a stationary structure was subjected to certain stresses and had been designed to withstand these stresses, but that in its abnormal capacity as a moving structure, other and different stresses were induced, which must be provided against by supplementing the original construction.

Having determined upon the necessary bracing, attention was turned to the problem of carrying a load of 6,652 tons over the yielding ground without cracking the masonry, when 1,430 tons of that load was concentrated on an area 24x24 ft. Tests were first made to determine the load the earth would bear without settling. This being known, a floor of 12x12 in. timbers was laid, entirely covering the ground on which the church stood and over which it would travel. On this floor a superstructure of screw jacks, timber and I-beams was constructed, as shown in Figs. 2 and 3. These illustrations show this arrangement for the tower only, but it was similar for all the remainder of the building. It will be noticed that on the top layer

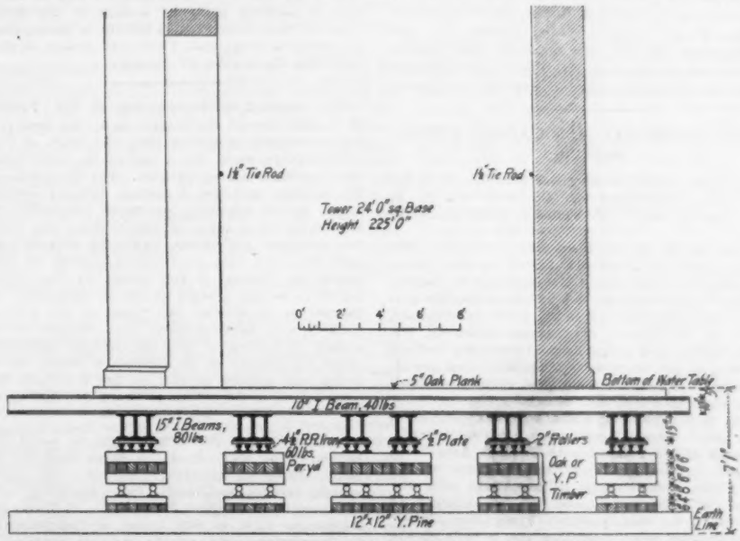



FIG. 3.—CROSS SECTION SHOWING SUPPORTS AND TRACK SYSTEM UNDER TOWER; IMMANUEL BAPTIST CHURCH, CHICAGO.

of timbers 60-lb. steel railway rails were placed to form a track on which the building could travel. Running on these rails were 2-in. steel rollers and on top of the rollers came the lining* and then the two systems of I-beams. Altogether 1,600 rollers and 135 tons of rail were used. To prevent the lining from shifting it was bedded to the I-beams above with car wheel paper.

Every precaution was taken against delay or accident. It was calculated that the ground and timber supports would settle as the load came onto them, and an up grade of 2 ins. in 30 ft. was given to the track rails. Care was even taken to have the rollers made of steel of the same hardness as the track rails so that they would not flatten and wedge. To prevent the rollers from "twisting" out of line the lining was so constructed in short plates that after a foot or so of travel each roller was released and could be put in again in exact line.

To apply the power for moving the building a strong timber was fastened at A (Fig. 2) as an anchorage. From this anchorage chains extended back to hold the timber B, which acted as a footing against which the screw-jacks pushed. The jacks were placed about as shown. Altogether 60 jacks were used and they were so arranged as to distribute the pressure evenly along the side of the building.

Everything being ready, the small screw-jacks underneath were operated and the building raised about $\frac{1}{2}$ in. from its foundations and all the weight thrown onto the rollers. Power was then applied to the pushing jacks by hand, a man being stationed at each jack, who gave it a quarter turn at a signal. The average progress per ten-hour day was about 9 ft., and, as already stated, the total travel was 51 ft.

After the horizontal movement of 51 ft. was accomplished jacks were placed underneath the building and it was raised vertically $5\frac{1}{2}$ ft. to permit of a basement being added. No damage was done either to the interior or the walls of the building, not even a crack being discovered from top to bottom. It will be seen that this is a remarkable showing when the height and weight of the tower considered. The time taken to do the work was as follows: Preparations were begun Oct. 14 and the moving was completed Nov. 27, 1895. The raising was finished Dec. 11, and work is now in progress on the new foundation walls.

The contractor who did the moving was H. Sheeler, of Chicago, Ill., who gave bonds amounting to $50,000 to guarantee its successful prosecution. The remodeling of the church is being done under the direction of Holabird & Roche, Architects, Chicago, Ill. W. A. & E. A. Wells, Chicago, Ill., are the contractors for the new masonry and foundations. We are indebted to Mr. Sheeler for the matter from which this description has been prepared.

*A term in common use by house-movers to designate the pieces of wood or metal bearing directly on the rollers and so designed that the rollers are released after a certain length of travel and can be fed in again. The object is to prevent the "twisting" of the rollers.

## AMERICAN FORRESTRY ASSOCIATION.—ANNUAL MEETING.

The fourteenth annual meeting was held Jan. 24, at the Cosmos Club, Washington, D. C., with Mr. B. E. Fernow, Chief of the U. S. Forestry Division, in the chair.

The report of the executive committee showed a very considerable increase of interest in the forestry movement. Owing to unfortunate circumstances in legislative procedure, the action of the Senate on the bill providing for the administration of the forest reservations, introduced in the House of Representatives by Mr. Thomas C. McRae, and passed by the House, was delayed so that Congress adjourned without the bill being passed. In the present Congress the same bills, slightly modified, have been introduced into each house, by Senator Teller and by Mr. McRae. Several states have also progressed towards a more rational forest policy. In Pennsylvania, the campaign of the Pennsylvania Forestry Association has resulted in the permanent establishment of the office of Forest Commissioner in connection with the Department of Agriculture, and the appointment of Prof. Rothrock to that position. From New Jersey comes encouraging news regarding the growth of the State Forestry Association. The two states of Minnesota and Wisconsin, alarmed by the disastrous fires of the preceding year, were induced to pass forest fire legislation, proposed by the forestry associations of the respective states. In Minnesota, a special fire forest fire warden is active in organizing the fire service, while in Wisconsin the function is unfortunately assigned to an officer already charged with other duties. The Forest Commission of New Hampshire continues its efforts to lay the basis for a permanent forest policy in the state. The Forest Commission of Maine, in addition to exercising the functions of a fire warden, issues a valuable report, with studies of the mercantile side of forestry growth in that state. New York has increased the area of the Adirondack Reserve by the purchase of 75,000 acres. For the Southern states an opportunity was had at the Cotton State & International Exposition to present not only the wealth and varied character of their forest resources, but also their condition, their reckless exploitation, and the evil consequences of irrational deforestation.

In the far West there is a growing appreciation of a needed change in the national forest policy, and although in California and Colorado no return to the official recognition of the abandoned state policy can be noted, the interest seems more generally diffused among the people. In Utah a forestry association has been organized, and from Montana indications come of the possibility of establishing one.

Two special meetings of the association were held during the year, the one a peripatetic meeting in May, in connection with and at the invitation of the New Jersey Forestry Association, to inspect the encroachment of the sand dunes, as a result of the destruction of the protecting forest cover, and also to give an impetus to the efforts for securing protection against forest fires which ravage the plains of that state. The other meeting was held at the invitation of citizens of Springfield, Mass., in connection with the meeting of the American Association for the Advancement of Science. At this latter meeting the executive committee was instructed to exert itself in securing the appointment of a commission to investigate and report on the condition of public timberlands, as a basis for further legislation. It was, however, decided by the executive committee that such a movement would prove prejudicial to the passage of the definite legislation now before Congress. The Secretary of the Interior, however, who again in his annual report refers in strong language to the need of a change in policy with regard to the public timberlands, has proposed to submit the question to the National Academy of Science, the legally constituted adviser of the government on matters scientific, asking for an expression of opinion on the need and manner of such change.

Mr. J. Sterling Morton, Secretary of Agriculture, was re-elected president of the association, and Mr. F. H. Newell, of the U. S. Geological Survey, was elected corresponding-secretary, to succeed Mr. H. H. Egleston, resigned.

A joint evening session was held with the National Geographic Society, at Metzerott Hall. Hon. J. Sterling Morton, Secretary of Agriculture, and president of the association, presided, and read an address upon the rapid destruction of the forests, the great exports of lumber and the loss of fertility of the soil due to unrestricted and reckless cutting of the valuable timber resources. He called attention to the estimates of Prof. N. S. Shaler, on the rapid defertilization and to the annual loss of farming lands by erosion of the soil. Other speakers were Hon. Fred T. Dubois, of Idaho; Hon. John F. Lacey, of Iowa; Hon. Thomas C. McRae, of Arkansas, and Wm. E. Smythe, of Chicago.

The proposed double-tracking of the Pennsylvania R. R. line through Burlington, N. J., has been prevented by an absolute injunction from the Court of Chancery. The proposed work was a part of the improvements on the Camden & Amboy Division. The Vice-Chancellor, in his decision, said that a railway company operating by steam cannot construct its tracks longitudinally upon any street of a town or city without the consent of the municipal authorities, unless by express legislative authority, and that no common council or governing board can dispose of any rights to the streets and highways to any private person or corporation in such manner as to abridge the rights of the public. The road is now double-tracked from Camden to the old station of Burlington, and the company contended that under the charter of the Camden & Amboy R. R. Co., which was granted in 1832, it had the right to lay a double track in the middle of Broad St., Burlington.

A tunnel under the Pennsylvania R. R. at Point of Rocks, Jersey City, N. J., is being built by the National Docks & Junction Connecting Ry. under peculiarly difficult conditions. The Connecting railway is to extend from the West Shore R. R., at Weehawken, to the Central R. R. of New Jersey, at Communipaw, having connections with all the railways entering Jersey City and Hoboken. The last link is that under the Pennsylvania R. R., whose roadbed here is 470 ft. wide, and has about 40 tracks. The Pennsylvania R. R. opposed the work on the ground that the top of the arch would be too near the grade line for safety, and when work was commenced some months ago, the Pennsylvania stationed a gravel train at the same spot and unloaded rocks, gravel and earth, driving away the workmen. The Connecting company, however, has obtained an injunction, which empowers it to remove three of the Pennsylvania R. R. tracks at a time for a length of 55 ft. The latter road is permitted to occupy its tracks, and therefore placed old cars upon them, in the hope that the men would be afraid to excavate under them. The work has been started, however, and several cars have tumbled into the excavation, the wreckage being removed by means of locomotives on the Connecting railway tracks, which are laid close up to the excavation.

The block system is to be introduced on the Prairie du Chien Division of the Chicago, Milwaukee & St. Paul Ry. The system has been in use for some time on the Chicago and La Crosse divisions, and has recently been established on the Superior division.

Complete specifications for a drainage system for New Orleans have been submitted to the City Council by Mr. L. W. Brown, City Engineer. The specifications have been approved by a board of advisory engineers, consisting of Messrs. B. R. Harrod, Henry B. Richardson and Rudolph Hering. The estimated cost of the work is about $8,000,000. Its main features are canals and pumping stations. Since the above was written the City Council has approved the specifications and ordered that bids be asked on the work for 30 days. The shortness of the time for receiving bids met with much criticism, and efforts were at once started to secure a veto of the measure.

Applications for the position of electrical engineer to the government of Queensland, Australia, will be received until March 2, by the Agent-General for Queensland, 1 Victoria St., London, England. The salary will be $3,000 per year, with traveling allowances. The duties of the engineer will be to advise the Post and Telegraph Department (of which Department he will be an officer) upon all matters connected with the telegraph, telephone and cable systems of the colony, the purchase and testing of material, the introduction of improved methods of working and of new apparatus, the training of the staff, and generally on the economical and efficient working of the service. He will also be required to advise the government upon all questions relating to electric lighting and motive power.

The present engineering staff of the Chicago Drainage Commission numbers 112. By the suggestion of the Engineering Committee of the Board of Trustees, this is to be reduced to 84, and 36 men have already been discharged in the line of reorganization. As others are to be discharged, there will evidently be vacancies to fill by the new board. The construction department is also to be reorganized on the basis of three divisions, and all assignments in this and the engineering staff are to be made by the Chief Engineer. At present the President, clerk of the board and the Marshal control the administration of canal police affairs, though the two latter are not members of the board. It is now proposed to place this administration in the hands of the Committee on Health and Public Order.

Electric motor cars are to be tried on the Manhattan Elevated Ry. in New York city. The system to be experimented with is that controlled by the Electric Storage Battery Co., of Philadelphia, in which the motor car has a storage battery sufficiently powerful to operate it for a round trip. The battery furnishes part of the current required by the motors when starting a train or climbing a steep grade, and all the current when the motor car is on a curve or on side tracks at terminals. On the other hand, when the train is running on a straight and level track the current-distributing rail furnishes current in excess of that required by the motors, which goes to charge the batteries. A special advantage of this system of elevated railway service is that breaks in the line by fire or accident do not stop the operation of the whole road, as the trains can be run by battery alone over such portions of the line as are dead. It is also stated that the main power station to supply the system will be placed at a point where fuel can be received by water, and condensing engines can be used, and a high potential alternating current will be used from there to various sub-stations along the line. Step-down and rotary transformers in these stations will convert the current to a low-potential direct current for transmission through the third rail. The tests with this system are to be made on the branch to the 34th St. Ferry.

Dredging in the Chicago River of an amount which will cost about $1,000,000 is urgently needed, and Congress is asked to appropriate this sum by a conference of the river and harbor interests of Chicago. Previous to 1891 the city expended about $75,000 annually in this work, but in the year named the Federal Government assumed absolute control of the river, and all further improvement required the sanction of the Department. The present condition of the river is such that immediate dredging is necessary for the passage of large boats, and the street tunnels present serious problems in connection with a greater depth. Over the La Salle St. tunnel there is 14 ft. of water, but at low water in the lakes this depth is only 12 ft., and large boats find the passage dangerous. The Illinois delegation in Congress will contend for the insertion of this item in the River and Harbor bill.